U. S. DEPARTMENT OF AGRICULTURE.
FORESTRY DIVISION.
BULLETIN No. 8.

TIMBER PHYSICS.

PART II.

PROGRESS REPORT.

RESULTS OF INVESTIGATIONS ON LONG-LEAF PINE.
(PINUS PALUSTRIS.)

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UNDER THE DIRECTION OF
B. E. FERNOW,
CHIEF OF FORESTRY DIVISION.

PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE.

WASHINGTON:
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY,
Washington, D. C., February 1, 1893.

SIR: I have the honor herewith to submit for publication a "Progress Report" on investigations undertaken by this Division into the nature of our important woods, being the second of a series of bulletins on Timber Physics. It contains the results of tests for strength made on the long-leaf pine collected in Alabama and a comparative study by Prof. J. B. Johnson of the various exhibitions of strength as related to each other and as dependent on certain conditions of the test specimens.

I would call especial attention to the comparison of bled and unbled timber, which is accompanied by a study into the chemical conditions of this timber by Mr. M. Gomberg. An account of the general characteristics of the timber of long-leaf pine and of the geographical distribution of the species and a brief recapitulation of the methods pursued in this work are added.

Respectfully,

B. E. FERNOW,
Chief.

HON. J. M. RUSK,
Secretary.

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TIMBER PHYSICS.

INTRODUCTORY.

The progress report herewith presented on the work of timber investigations is published in less complete form than had been contemplated, in order to avoid longer delay in bringing results before the public. The delay is occasioned by inadequate appropriations for the work; and since the work is now to be stopped entirely for lack of funds, it was thought best to publish what results were in such shape as to present valuable information.

The data contained in the report refer altogether to the timber of long-leaf pine (*P. palustris*) from Alabama, being the results of mechanical tests obtained in the test laboratory under direction of Prof. J. B. Johnson at St. Louis. These data refer to over 2,000 tests on material furnished by twenty-six trees collected from four different sites by Dr. Charles Mohr.

These tests may be said to represent fairly well the range of strength pertaining to the species, unless unexpected differences are found in the material collected from other climatic stations. Such material has been collected from Louisiana and Texas, but the lack of funds mentioned before has prevented its utilization for this report.

The following table represents the range of value of the various exhibitions of strength as compiled from Table I of Prof. Johnson's report:

Condensed table of mechanical properties of Long-leaf Pine.

[Ranges reduced to 15 per cent moisture.]

	Specific gravity.	Cross bending tests.			Crushing endwise.	Crushing across grain.	Tension.	Shearing.	Modulus of strength at elastic limit.
		Strength, $F = \frac{3 w L}{2 b h^2}$.	Modulus of elasticity.	Relative elastic resilience in in. lbs. per cu. in.	Strength, per sq. in.	Strength, per sq. in.	Strength, per sq. in.	Strength (mean), per sq. in.	Per sq. in. $F = \frac{3 w L}{2 b h^2}$.
Butt logs......	0.449—1.039	4762—16200	1118800—3117370	0.23—4.69	4781—9850	675—2094	8600—31890	464—1299	4930—13110
Middle logs...	0.575—0.859	7640—17128	1136120—2981720	1.34—4.21	5030—9300	656—1445	6330—29500	539—1230	5540—11790
Top logs......	0.484—0.907	4268—15554	842000—2697460	0.09—4.65	4587—9100	584—1766	4170—23280	484—1156	2553—11950

Prof. Johnson has attempted to relate the values of strength to other qualities, especially moisture contents of the test piece, and compared the various exhibitions of strength with each other, to find if possible their relation. It is to be understood that this discussion refers only to the species in hand, and does not admit of generalization to other timbers.

Some of the deductions for the long-leaf pine may even have to be modified upon further study. We summarize the more important deductions as follows:

(1) With the exception of tensile strength, a reduction of moisture is accompanied by an increase in strength, stiffness, and toughness.

(2) Variation in strength goes generally hand in hand with variation in specific gravity.

(3) The strongest timber is found in a region lying between the pith and the sap at about one-third of the radius from the pith in the butt log; in the top log the heart portion seems strongest. The difference in strength in the same log ranges, however, not over 12 per cent of the average, except in crushing across the grain and shearing, where no relation according to radial situation is apparent.

(4) Regarding the variation of strength with the height in the tree, it was found that for the first 20 to 30 feet the values remain constant, then occurs a more or less gradual decrease of strength, which finally, at the height of 70 feet, amounts to 20 to 40 per cent of that of the butt log for the various exhibitions of strength.

(5) In shearing and crushing across and parallel with the grain, practically no difference was found.

(6) Large beams appear 10 to 20 per cent weaker than small pieces.

(7) Compression tests seem to furnish the best average statement of value of wood, and if one test only can be made this is the safest, as was also recognized by Bauschinger.

The investigations into the effect of bleeding the trees for turpentine leave now no doubt of the fact announced in a preliminary circular, that bled timber is in no respect inferior to unbled timber.

This conclusion, to which the mechanical tests lent countenance, is strengthened by the chemical study of Mr. M. Gomberg into the distribution of resinous contents throughout the trees bled and unbled. These show what physiological considerations would lead us to anticipate, that the resinous contents of the heart wood take no part in the flow of resin induced by the "boxing" or "chipping" of the tree, being nonfluid, and also being found present in larger amounts in the heart wood than in the sap wood as well before as after bleeding. The drain appears to be entirely from the sap wood, and as this does not enter into lumber production, being hardly more than two inches on the radius, it may be left out of consideration.

The result of the tests, to the effect that bled timber is stronger than unbled, which Prof. Johnson proposes to explain as a result of the bleeding, does not seem to admit of such reference. It is suspected that the timber from the orchard might have come from a locality the soil conditions of which were apt to produce better quality, the comparison of bled and unbled timber having been made on material from different localities.

From the field report of Mr. Roth it would appear that opinions of practical men are so much at variance as to the effect of bleeding as to be of no special value, and we can claim that the discrimination made against bled timber, be it on account of inferior strength or inferior durability, is due to an unwarranted prejudice.

The physiological considerations and the processes employed in the gathering of turpentine in this and other countries will be found fully discussed in the annual report of the Forestry Division for the year 1892.

The arduous and difficult task of collecting the test material in the careful manner required for this work has been performed by Dr. Charles Mohr in a most efficient manner. An inspection of the field records will give an idea of what this involves in the way of selecting, examining, and describing sites and specimens, but no idea of the hardships which are encountered in the performance of the work of securing and shipping logs and disks. There are now collected, in all, specimens from 233 trees, on twenty different sites, of *Pinus palustris, echinata, Taeda, Quercus michauxii, rubra, falcata, Phellos, tinctoria, alba, obtusiloba*, comprising in all 409 logs and 1,855 disks.

Thanks are due to the management of the Louisville and Nashville, the Iron Mountain, and the Southern Pacific railways for free transportation of men and materials, without which, in the face of scant appropriations, the progress could not have been as rapid.

Regarding the methods used in analyzing and comparing the results of tests, we are indebted to Mr. William Kent, C. E., for valuable suggestions. The idea of the "average quality" is his own. This, to be sure, does not pretend to be an expression of actual quality, but serves the useful purpose of a practicable basis for arrangement of material for comparison.

On the whole, the methods of handling the very large amount of data from mechanical and physical examinations for comparative study have not yet been fully matured and determined upon.

It is contemplated, when work can be resumed, to study as a separate series the influence of various methods of seasoning upon quality, besides extending the mechanical tests to a number of important species that are still imperfectly known in their properties, like the Douglas spruce and the bald cypress. The work will progress and results be published in proportion to the funds appropriated for the investigations.

B. E. FERNOW.

MECHANICAL TESTS MADE AT WASHINGTON UNIVERSITY TESTING LABORATORY, ST. LOUIS, MO

Written by Prof. J. B. Johnson (reprinted with corrections from Bulletin 6).

SAWING, STORING, AND SEASONING.

On arrival of the logs in St. Louis they were sent to a sawmill and cut into sticks, as shown in Figs. 1 to 4.

In all cases the arrangements shown in Figs. 1 and 2 were used, except when a detailed study of the timber in all parts of the cross-section of the log was intended. A few of the most perfect logs of each species were cut up into small sticks, as shown in Figs. 3 and 4. The logs tested for determining the effects of extracting the turpentine from the Southern pitch pines were all cut into small sticks.

In all cases a "small stick" is nominally 4 inches square, but when dressed down for testing may be as small as $3\frac{1}{2}$ inches square. The "large sticks" vary from 6 by 12 to 8 by 16 inches in cross-section.

All logs varied from 12 to 18 feet in length. They all had a north and south diametral line, together with the number of the tree and of the log plainly marked on their larger or lower ends.

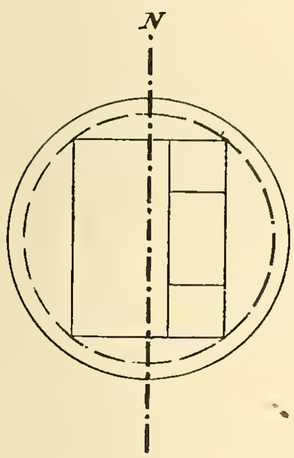


Fig. 1.

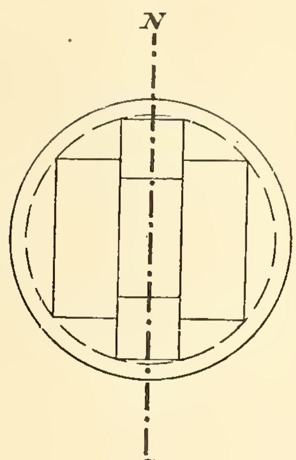


Fig. 2.

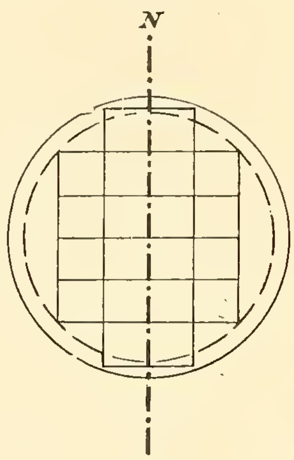


Fig. 3.

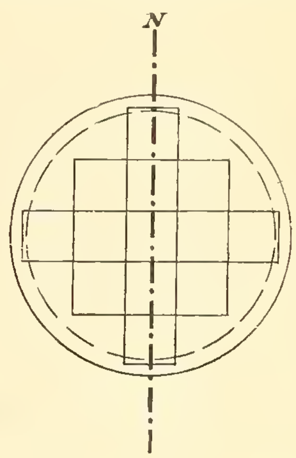


Fig. 4.

The stenciled lines for sawing were adjusted to this north and south line, as shown in the figures. Each space was then branded by deep dies with three numbers, as for instance thus: $\begin{matrix}25\\2\\4\end{matrix}$, which signifies that this stick was number 4, in log 2, of tree 25. A facsimile of the stenciling was recorded in the log book, and the sticks there numbered to correspond with the numbering on the logs. After sawing, each stick can be identified and its exact origin determined. These three numbers, then, become the identification marks for all specimens cut from this stick, and they accompany the results of tests in all the records.

After sawing, the timbers were stored in the laboratory until they were tested. The "green tests" were made usually within two months after sawing, while the "dry tests" were made at various subsequent times. One end (60 inches) of each small stick was tested green, and the other end reserved and tested after seasoning. The seasoning was hastened in some cases by

means of the drying box shown on Plate I. The temperature of the inflowing air in this drying box was kept at about 100° F., with suitable precautions against the checking of the wood, and the air was exhausted by means of a fan. The air was, therefore, somewhat rarefied in the box. The temperature was at all times under control. It operated when the fan was running, and this was only during working hours.

THE TESTING LABORATORY.

The testing laboratory is the basement story of the gymnasium building of Washington University. Its dimensions are 71 by 46 feet, with one corner partitioned off, as shown on the floor plan, Plate I. The net area used for laboratory purposes is 2,500 square feet. All the apparatus suspended from the ceiling, as shafting, steam pipes, exhaust fan, etc., is shown in dotted lines.

The apparatus pertinent to the timber tests consists of a 1,000,000-pound column-testing machine; one 100,000-pound beam-testing machine, one 100,000-pound universal testing machine, of Riehlé's "Harvard" pattern; one small portable beam machine, one 6-horse power Brayton coal-oil engine, one 4-horse power steam engine, one planer and one lathe, for ironwork; one planer, one band saw, and one cutting-off saw, for shaping and dressing wood specimens; suitable scales, drying ovens, etc., for the moisture and specific gravity tests; the drying box with its steam coils and exhaust fan, and all the necessary appliances, benches, tools, desks, etc., including a Thatcher's slide rule for making the computations. The timber is stored in various parts of the room not otherwise utilized. The broken specimens are stored in the museum building at the Missouri Botanical Gardens.

DESCRIPTION OF TESTS.

The cross-breaking tests.

Large beams.—The large beams are tested on the large beam-testing machine shown on Plate II. The base of this machine consists of two long-leaf pine sticks (*Pinus palustris*) 6 inches by 18 inches by 24 feet long, with a steel plate three-fourths of an inch by 18 inches by 20 feet long, all bolted up as one beam. The power is applied by hydraulic pressure upon a plunger below, to the crosshead of which are attached the two side screws, on which the upper crosshead is moved by sleeve nuts and spur gearing. The beam to be tested rests on pivots at the ends, placed on top of the base beam, and the upper crosshead is moved down by means of the gearing until the central pivot attached to it comes in contact with the beam, or rather with the distribution blocks placed on the beam at this point. The test then begins, the power originating in a double-plunger pump, operated by hand or by steam power in another part of the room.

To prevent the pivots or "knife-edges" from crushing into the timber, it is necessary to make the contact at both ends and center, first upon a cast-iron plate, then through longer wooden blocks to the timber. The center block is curved somewhat on the lower side, to allow for a considerable deflection in the beam when nearing its maximum load.

In the tests of all beams, both large and small, the load is put on at the same uniform rate, so as to eliminate the time effect, which is very great in timber tests. The load on the small beams is increased at such a rate as to produce an increase in the deflection of one-eighth inch per minute without any pause until rupture occurs. This causes rupture in from ten to fifteen minutes time. The load is read off when it reaches certain even amounts, and an observer notes the corresponding deflection without stopping the test. The time required for the large beam tests is about the same, the deflection rate being greater when the total deflection is expected to be greater, as is the case with 4 by 8 inch sticks 12 feet long. The deflections of the large beams are observed upon a polished metallic scale, graduated to inches and tenths, which is tacked to one side of the stick at the center. A fine thread is stretched, by means of a rubber band, over nails driven into the side of the stick above the end supports on the line of the neutral axis. This string or thread is moved about an inch away from the surface of the timber, and all parallax, or error of reading from an oblique position of the eye, is avoided by keeping the eye where the thread and its image in the metallic mirror coincide and form one and the same line. The readings are taken to inches and hundredths by estimating the tenths of the graduation spaces on the scale.

The loads are weighed on the large universal testing machine in another part of the room. This is done by having both machines connected up to the same pump, blocking the weighing machine so that the load on its plunger is transmitted to the scales and weighing beam, and then pumping into both machines. The plungers are of exactly the same diameter; they have similar leather cup packing, and hence the error of this method is simply the difference in the friction of the two plungers in their packing rings. To test the accuracy of this method, and to determine the error, if any, at any time, a nest of calibrating springs (shown on Plate II) was made and tested first on the Emery machine at the United States Arsenal, at Watertown, Mass. The loads were found which corresponded to given deflections, or in other words the stress diagram of these springs up to a 30,000-pound load, which corresponds to a little more than one inch elastic deflection. By repeating this test on the 100,000-pound universal or weighing machine, and then on the large beam machine, and plotting the stress diagrams obtained from each, not only can these machines be compared with each other, but both can be compared or calibrated with the Emery machine at the Watertown Arsenal.

In Fig. 5 the three curves corresponding to the three machines are given. They are so nearly coincident that it is shown that not only is the universal 100,000-pound Riehlé machine correctly

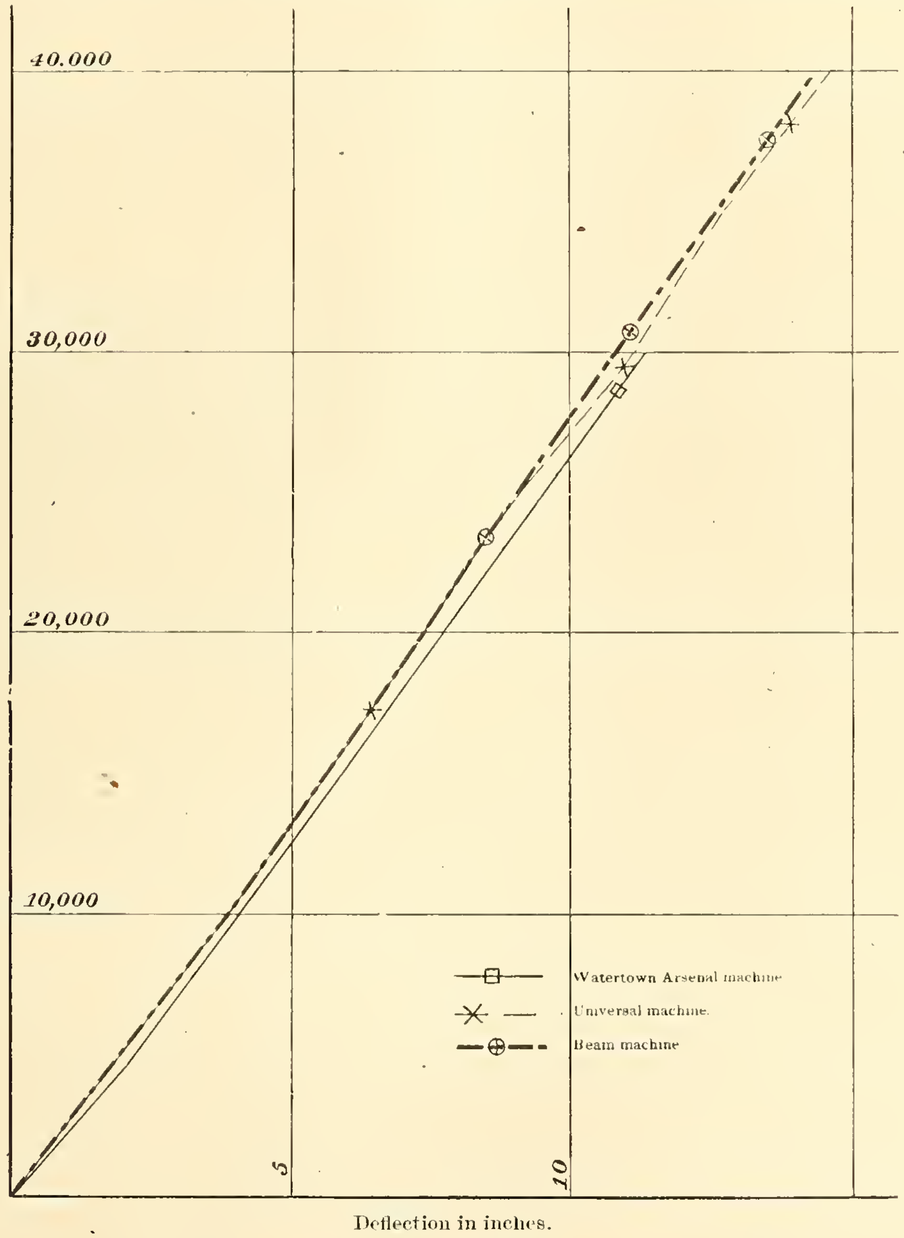


Fig. 5.—Standardizing tests with calibrating springs.

graduated, but that the method used of weighing the loads on the beam machine by means of the universal machine results in no appreciable error. This test can be applied at any time, and proof

readings have been made at frequent intervals. The beam machine is greatly simplified by thus dispensing with all attached weighing apparatus, which would be greatly in the way in the handling of large beams sometimes weighing over 1,000 pounds.

Small beams.—The small beams, which are nominally 4 inches square and 60 inches long between supports, are tested on the small beam-testing machines (shown on Plate III). This machine was designed originally for testing cast-iron beams, the load at one end or one-half the load at the center being weighed on a pair of ordinary platform scales. The deflections are read off to thousandths of an inch upon a micrometer screw held in the top iron crossbeam. By this means a rigid connection is obtained, through parts not under stress, from the end supports to the center bearings. The movement of the center with reference to the ends is therefore obtained, regardless of the absolute movements of the parts. The load is put on by the hand wheel and power screw, and the weighing beam kept in balance by putting on overweights and moving the poise. Three men are required to make this test. One moves the power screw, which has one-forth inch pitch, so as to make one revolution every two minutes, and he continues this uniform motion till rupture occurs. Another keeps the scales balanced and calls off the even hundreds of pounds. Another keeps the micrometer screw in contact with the head of the power screw, reads it for certain even hundred-pound loads called off, and records the time of each such reading to the nearest minute, the load, and the corresponding reading of the micrometer screw. Here also the end and center bearings are protected by iron plates large enough to prevent any appreciable distortion from lateral compression.*

After rupture occurs the stick is bored for samples from which to obtain the moisture tests and the uninjured ends are sawed off and used for the remaining tests, as described below.

The moisture test.†

The borings are taken from two holes, 20 inches from each end and at about one-third the width of the stick from either side. These borings are first weighed on a delicate balance, then placed in a drying oven, at a temperature of 212° F., until they have reached a nearly constant weight, when they are reweighed. The dry weight is taken as the basis on which to compute the percentage of moisture. Thus, if the original weight is twice the final weight, then there was as much water as woody fiber in the stick, or one-half or 50 per cent of the original weight was water. But when computed on the basis of the dry weight there would be 100 per cent of water. The advantage of computing the percentage on the dry weight is that it furnishes a constant basis of comparison, whereas if computed on the actual or wet weight the basis on which the percentage would be computed would vary with every change in the amount of moisture.

The specific gravity.

The specific gravity is found by taking one of the end pieces, usually 4 by 4 by 8 inches, measuring carefully its lateral dimensions by calipering them at the middle points of the sides at the central section, measuring the length in a similar manner, and taking the product of these three dimensions as the volume. From the total volume and the actual total weight, the weight per unit volume or per cubic foot is found, and from this the specific gravity, which is the weight per cubic foot divided by the weight of a cubic foot of distilled water. It must be understood that all the small (4 by 4 inch) beams are planed up true and rectangular before testing and that all the crosscuts are made by power saw so adjusted as to cut truly at right angles to the sides. The volume can therefore be very accurately computed from the dimensions as above described.

* Since December 1, 1892, all tests made on this small machine are arranged with two center bearings, 12 inches apart, on sticks 72 inches long.

† The percentage of moisture is now found by sawing off a thin section of the entire stick and using it in place of the borings.

The tension test.

The tension test piece is cut from one end of the broken beam. It is 16 inches long, $2\frac{1}{2}$ inches wide, and $1\frac{1}{2}$ inches thick. Its thickness at the center is reduced by cutting out with a band saw circular segments, leaving a breaking section of some $2\frac{1}{2}$ inches by three-eighths inch. This specimen is then placed between the plane wedge-shaped steel grips and pulled, the same as a bar of iron in the Universal Machine (shown on Plate IV). This simple method has been found very satisfactory in practice and is fully illustrated on Plate V. For this test care is taken to cut the specimen as nearly parallel to the grain of the wood as possible, so that its failure will occur in a condition of pure tension.

The endwise compression test.

Most of these tests are made on sticks 4 inches square by 8 inches long, the ends having been cut perfectly true and at right angles to the sides. They are tested in the Universal Machine, the compression continuing until the stick has been visibly crushed and has passed its maximum load. The crushing usually manifests itself over a plane section, by crushing down or bending over all the fibers at this section, which may be either a right or an oblique section. The section of failure, however, is seldem at the very end. The slightest source of weakness may determine its position, as a very small knot for example, for knots are a source of weakness, in compression as well as in tension.

Some tests are made on columns 40 inches long by 4 inches square on the large beam machine, but these usually fail the same as the short blocks, and not by bending sidewise.

Compression across the grain.

Specimens 4 inches square and 6 inches long are tested in compression across the grain. An arbitrary limit of distortion, namely 3 per cent of the height, has been chosen as a reasonable maximum allowable distortion in practice. This limit is indicated in the test by the ringing of an electric bell and the load then on the specimen is called the compressive strength across the grain. The test is then continued until the distortion has reached 15 per cent of its height, and both results are given in the records.

The shearing tests.

Since timber fails by shearing or splitting oftener than any other way, this test becomes a very important one. The specimen is taken 2 inches square and 8 inches long, and rectangular holes mortised 1 inch from each end and at right angles to each other, as shown on Plate V. The specimen is then pulled, in the Universal Machine, by means of suitable stirrups and keys, as shown in the plate. The ends are kept from spreading or splitting by putting on small clamps, with just enough initial stress in them to hold them in place. After one end shears out two auxiliary hoops or stirrups are used to connect the key which sheared out to a pin put through the hole at the center of the specimen, as shown. The other end is then sheared, and two results are obtained on planes at right angles to each other. In this way the shearing strength is determined on two planes at right angles to each other.

Test of full-sized columns.

No set of experimental tests of timber would be complete without numerous tests on full-sized columns. This requires a machine of not less than 1,000,000 pounds capacity, capable of crushing to failure columns from 12 to 14 inches square and at least 30 feet long. Such a machine has been built expressly for this work and is shown on Plate VI. It is capable of exerting a compressive force of 1,000,000 pounds on a length of 36 feet or less. The sides or tension members of this machine are made of four long-leaf yellow pine sticks (*Pinus palustrus*), from Georgia, each 8 by 12 inches and 45 feet long. The power is applied by the same hydraulic pump, which operates

both the large beam machine and the 100,000-pound universal machine. The loads are weighed on this latter machine the same as for the beam tests. The plunger in the column machine has just ten times the area of that in the weighing machine, and hence the loads in the column tests are just ten times those indicated on the weighing beam. The tail block is of cast iron, resting in a spherical socket, which is carried on a car and which can be held by struts resting in slots in the timber. The outer ends of these struts are kept from spreading by means of tiebars, as shown, and the whole combination can be moved forward or back, so as to make the distance between face plates any even number of feet from two to thirty-six. The spherical socket in the tail block will produce an accurate adjustment of the end bearings at the beginning of the test, but after the load is on it is thought that this joint will remain rigid, the same as a solid block, especially if precautions are taken to increase the frictional resistance between these bearing surfaces. This spherical socket is provided to eliminate the effects of unequal shrinkage in the side timbers or any unequal compression in the bearing sockets, and not to serve as a round-end bearing for the column. When long columns are tested a part of their weight will be supported by means of lines and pulleys, so as to make the test correspond to a vertical load in actual practice. No tests of columns on long-leaf yellow pine have been made on this machine at the time of the publication of this bulletin.

Significance of results.

From the cross-breaking tests are obtained the cross-breaking modulus of rupture, the modulus of strength at the elastic limit, the modulus of elasticity, or measure of the stiffness, and the elastic resilience, or measure of the toughness.

The loads and their corresponding deflections are plotted as rectangular coördinates, and the strength at the elastic limit, the modulus of elasticity, and the elastic resilience are obtained from a study of this strain diagram.

The following is an example of the record made for every beam test. This is a record of a test made on a 4 × 8 inch stick of long-leaf pine, 12 feet long, which was placed on supports 140 inches apart.

CROSS-BREAKING TEST.

Mark $\begin{cases} 16 \\ 3 \\ 1 \end{cases}$

Length, 140.0 inches.
Height, 8.04 inches.
Breadth, 4.02 inches.

Modulus of Ruptures.

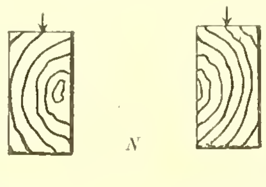
$$\text{where } f = \frac{3\,W\,l}{2\,b\,h^2} = 10{,}910 \text{ pounds per square inch.}$$

Modulus of Strength at the Elastic

$$\text{Limit} = f = \frac{3\,W'\,l}{2\,b\,h^2} = 8{,}100 \text{ pounds per square inch.}$$

Modulus of Elasticity = 2,070,000 pounds per square inch.
Total Resilience = 35,440 inch pounds.
Resilience, per cub. inch = 7.83 inch-pounds.
Total Elastic Resilience = 8,650 inch-pounds.
Elastic Resilience, per cubic inch = 1.91 inch-pounds.

[Number of annual rings per inch = 14.]

August 27, 1891.	Load.	Deflection.	Scale reading.	Remarks.
h. *m.*				
1 58	1,000	0.17	11.02	
59	2,000	0.34	11.19	
59	3,000	0.50	11.35	
2 00	4,000	0.66	11.51	
00	5,000	0.82	11.67	
01	6,000	0.96	11.81	
02	7,000	1.13	11.98	N
02	8,000	1.27	12.12	
03	9,000	1.46	12.31	
03	10,000	1.65	12.50	Butt end. Top end.
04	11,000	1.93	12.78	
05	12,000	2.27	13.12	
07	13,000	2.85	13.70	
09	13,500	3,85	14.70	Maximum load.

The observed data are given in the columns headed "Time," "Load," and "Scale reading." These results are recorded on this sheet in ink as they are observed. The result in the "Deflec-

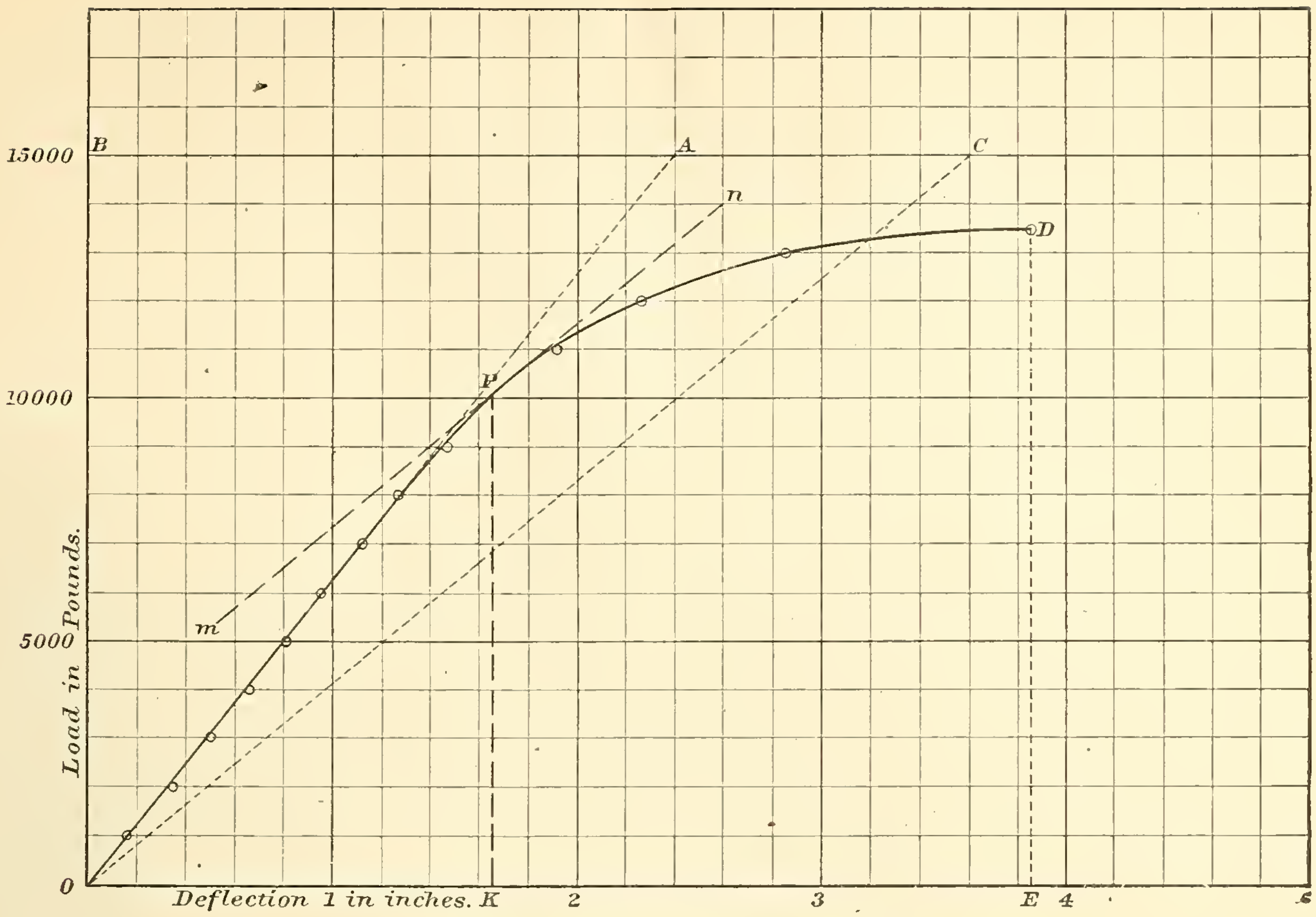


FIG. 6.—Determination of relative elastic resilience.

tion" column is computed from the scale reading. It is placed next to the column of "Loads" for convenience in plotting the strain diagram, which is done on the ruled squares at the bottom of each sheet. These plotted results fall in all cases on a true curve, similar to the one shown above. The total area of this curve *O. D. E.*, properly evaluated by the scales used, represents the total number of foot-pounds or inch-pounds of work done upon the stick before rupture occurred. This is called the *Total Cross-breaking Resilience* of the stick, and when divided by the volume of the stick in cubic inches it gives approximately the total cross-breaking resilience of the stick in inch-pounds per cubic inch of timber. (Fig. 6.)

A better criterion of toughness, or resistance to shock, is some definite portion of this strain diagram area, as *O P K*, for example. This amount of resilience or spring can be used over and over again, and is a true measure of the toughness of the timber as a working quality. To locate the point *P*, the following arbitrary rule has been followed.

Draw a tangent to the curve at the origin, as *O A*. Lay off $A\ C=\frac{1}{2}B\ A$ and draw *O C*. Draw *m n* parallel to *O C* and tangent to the curve. Take the point of tangency as the point *P* and draw *P K*. The area *O P K* is then called the *Relative Elastic Resilience.**

There is no "elastic limit" in timber as there is in rolled metals. In this respect it is like cast iron. The point *P* is the point where the rate of deflection is 50 per cent more than it is at first, and usually falls on that part of the curve where it begins to change rapidly into a horizontal direction or where the deflection begins to increase rapidly. The areas of these curves are measured with a planimeter and reduced to inch-pounds. Thus, if 1 inch vertically represents 5,000 pounds and 1 inch horizontally represents 1 inch deflection, then 1 square inch represents $5{,}000\times 1=5{,}000$ inch-pounds. If the area *O P K* is 1.73 square inches, then the corresponding resilience is 8,650 inch-pounds. This means that a weight of 100 pounds, falling 86.5 inches, or 1,000 pounds falling 8.65 inches, would have strained the beam up to the point *P* or it would have deflected it 1.66 inches, and the beam would have been then resisting with a force of 10,000 pounds, since *P* falls on the 10,000-pound line. If this result—8,650 inch-pounds—be divided by the number of

* This term has been coined to define this particular portion of the resilience which will be used for comparing the relative elasticity or toughness of different timbers.

cubic inches in the stick between end bearings, the result is the true *Relative Resilience in Cross-breaking* in inch-pounds per cubic inch. This result is independent of the dimensions of the test specimen and is therefore a true measure of the quality of timber which is usually known as toughness. It depends, as toughness in the usual understanding does, on both the strength and the deflection; in fact, it is very nearly the half product of the strength developed and the deflection produced at this particular point P. It is probably the nearest quantitative measure of the toughness that can be arrived at.

The *modulus of rupture* is computed by the ordinary formula—

$$f=\frac{3\,W\,l}{2\,b\,h^2}. \quad \ldots \quad (1)$$

where f=modulus of rupture in pounds per square inch,

W=load at center in pounds,

l=length of beam in inches,

b=breadth of beam in inches,

h=height of beam in inches.

In green timber, where the crushing strength is greatly reduced by the presence of the sap, the crushing resistance is only about one-third as much as the resistance to tension, so that the stick invariably begins to fail on the compression side. This causes the neutral plane or plane of no stress to be lowered, and at the time of final rupture this plane may be from one-fourth to one-sixth the depth from the bottom side of the beam. The value of f computed by this formula from a cross-breaking test, therefore, will always be intermediate between the crushing strength and the strength in tension. Thus the crushing strength of a given stick was found to be 5,820 pounds per square inch, while the tensile strength was 15,780 pounds; the cross-breaking strength was found by this test to be 10,900 pounds.

The *modulus of strength at the elastic limit* is found in the same manner as the above, except that for breaking load is taken the load at the point P, described above, this being called the "elastic limit," although strictly speaking timber is not perfectly elastic for any load if left on any great length of time.

The *modulus of elasticity* is computed from the formula—

$$E=\frac{W\,l^3}{48\,D\,I}=\frac{W\,l^3}{4\,D\,b\,h^3}=\frac{W}{D}\cdot\frac{l^3}{4\,b\,h^3} \quad \ldots \quad (2)$$

where E = modulus of elasticity,

and W, l, b, and h as in eq. (*1*)

D = deflection of beam.

I = moment of inertia of the cross-section = $\frac{1}{12} b\,h^3$ for rectangular sections.

To find this modulus, a tangent line is drawn to the strain diagram at its origin, as $O\,A$, and the coördinates of any point on this line used as the W and D from which to compute E.

The modulus is thus seen to vary directly as the load and inversely as the deflection; hence it is a true measure of the stiffness of the material. It is the most constant and reliable property of all kinds of engineering materials* and is a necessary means of computing all deflections or distortions under loads.

In using the modulus of elasticity of timber for computing deflections, it must be remembered that in this case the time effect is very great (it is nearly zero in metals) and that this factor can only be used to compute the deflection for temporary loads. The deflection of floor or roof timbers, for instance, under constant loads is a very different matter, as it increases with time.

BAUSCHINGER'S RELATIONS.

Relation between strength and stiffness.

In Fig. 7 is shown the relation found by Professor Bauschinger† between the modulus of elasticity (stiffness) and the cross-breaking strength, from tests on pine, larch, and fir timber. Although the results show a wide range, there is evidently a general relation between these two

* The wide range of values of the modulus of elasticity of the various metals, found in public records of tests, must be explained by erroneous methods of testing.

† See Pl. II, vol. 16, of Professor Bauschinger's Reports of Tests made at Government Testing Laboratory at Munich.

quantities, as indicated by the straight line drawn through the plotted points. The algebraic expression of the law shown by this line, rendered into pounds per square inch, is, in round numbers—

$$\text{Cross-breaking strength} = 0.0045 \text{ Modulus of Elasticity} + 450. \tag{3}$$

If it should be found that there is such a law for all kinds of timber, then there may be derived an equation of this form, but with different constants, for each species.

Relation between strength and weight.

In Fig. 8 is shown the relation between the crushing strength and the specific gravity, when both are reduced to the standard percentage of moisture, which was taken at 15 per cent.

These results are also taken from Professor Bauschinger's published records of tests on pine, larch, and fir timbers, and they conclusively show that the greater the weight the greater the strength of the timber. The law here is a well defined one, so far as these timbers are concerned. When rendered into English units (pounds per sq. in.), the equation of this line is:

$$\text{Crushing strength} = 13800 \text{ specific gravity} - 900. \tag{4}$$

when the timber contains but 15 per cent of moisture. This equation would also vary in its constants for each species of timber.

Relation between the compressive strength and the percentage of moisture.

In Fig. 9 are plotted some very careful tests by Prof. Bauschinger to show the relation between the percentage of moisture and the crushing strength.

There is no question but the crushing and the shearing strength are both greatly reduced by moisture. The crushing test also gives a very fair indication of the strength of the timber in all other ways. In this instance four sticks were taken and sections tested first green, or having an average of 37 per cent of moisture when computed on the wet weight, or 59 per cent of moisture when computed on the dry weight, as is the practice in the tests made by this Department. The sticks were then dried until there was an average of 14.6 per cent moisture on the wet weight, or 17 per cent of the dry weight. The remaining portions of the sticks were further seasoned until there remained but 8.2 per cent moisture computed on the wet weight, or 9 per cent moisture on the dry weight, and then tested. This is a smaller percentage of moisture than out-door lumber ever reaches, as the ordinary humidity of the external air will usually maintain at least 10 per cent of moisture in all kinds of timber.

When these three groups of results are plotted, and the most probable curve drawn through them, there is seen to be a remarkable increase in the crushing strength when the percentage of moisture falls below fifteen or twenty. The variation in strength above that limit is very small. Prof. Bauschinger has published a great many such curves, all showing the same general law. This curve illustrates the necessity for finding the percentage of moisture for every test of strength made.

Prof. Bauschinger has published very few tests showing the relations between the cross-breaking strength and the moisture, but Fig. 10 is a reproduction of such results as he has given. When the percentage of moisture sinks as low as 10 there appears a wide variation of strength, not satisfactorily explained. There would seem to be a law of dependence, however, but less marked than in the case of compressive strength.

Relation between specific gravity and moisture.

In Fig. 9 the "specific-gravity" curve shows the relation between the specific gravity and the percentage of moisture. At first the specific gravity diminishes rapidly as the percentage of moisture is reduced, but when this has been reduced to 15 per cent the specific gravity changes very little for any further reduction in moisture. This shows that the shrinkage is insignificant until the timber becomes nearly dry, when it swells and shrinks almost directly with the percentage of moisture, so that the weight of a unit volume, which is a measure of the specific gravity, remains nearly constant. This curve is also only one of a great many similar ones given by Prof. Bauschinger.

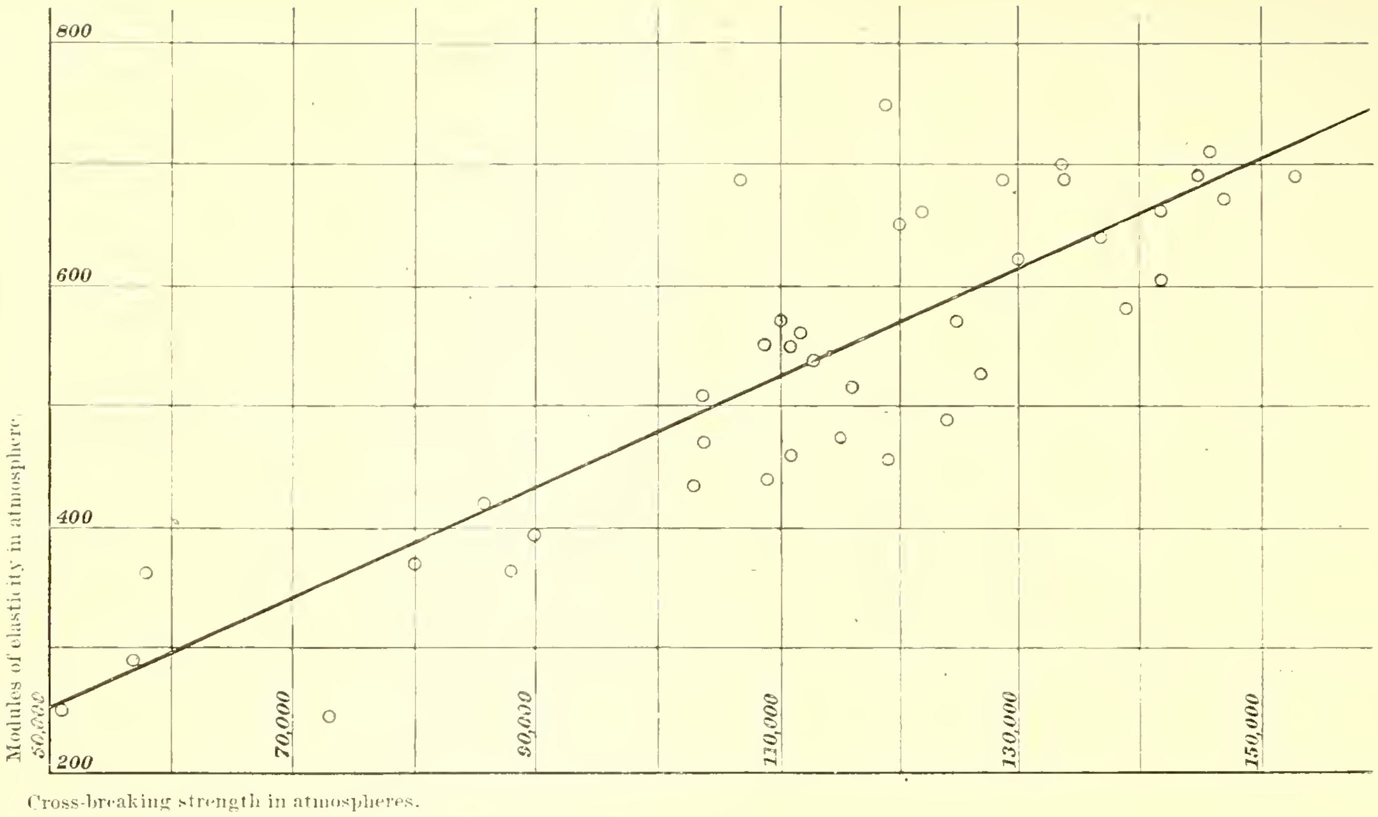


FIG. 7.—Relation between cross breaking strength and modulus of elasticity or stiffness for Pine, Larch, Spruce, and Fir timber. (After Bauschinger.)

[Cross-breaking strength = 0.0045 modulus of elasticity + 450.]

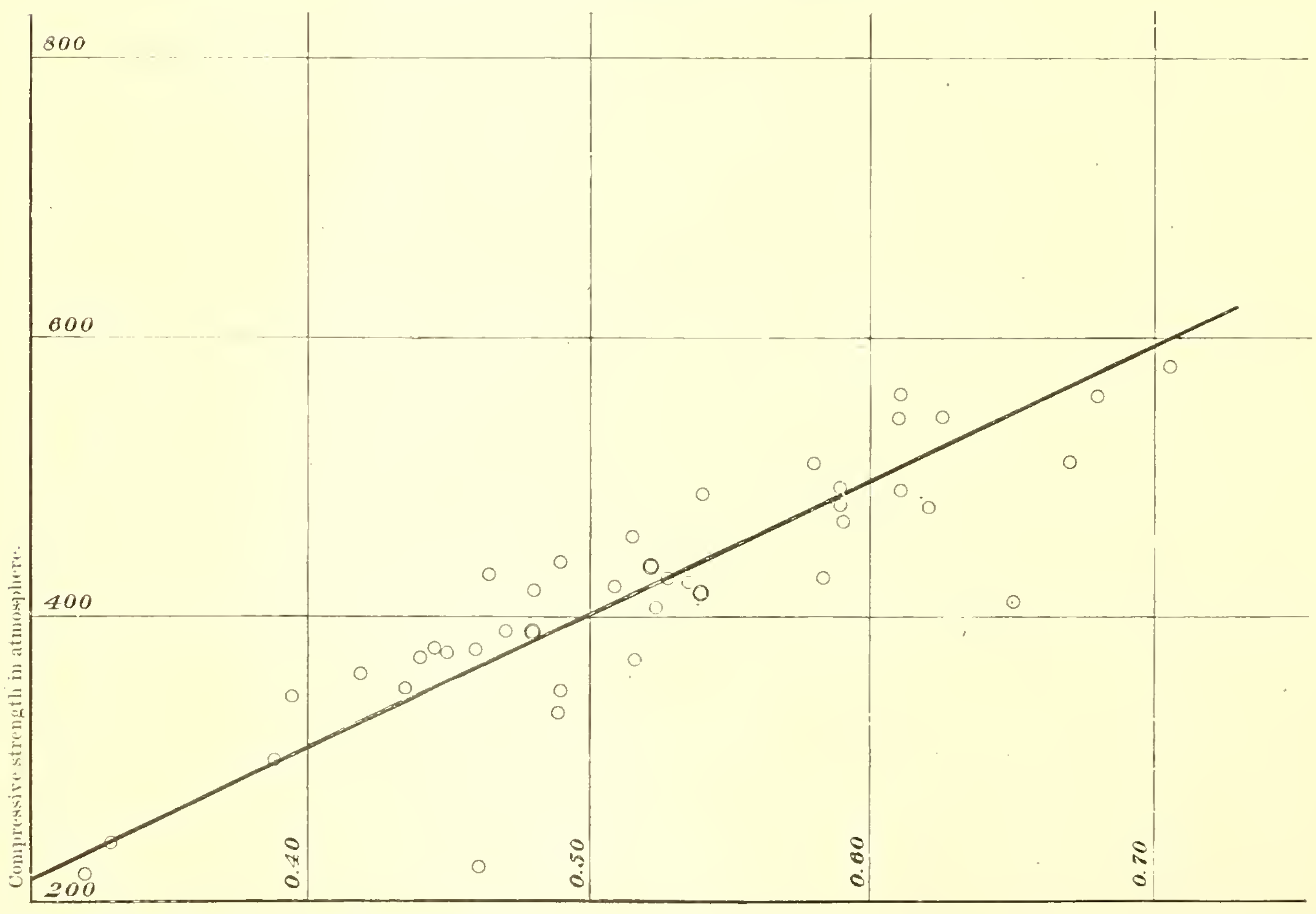


FIG. 8.—Relation between compressive strength and specific gravity or weight for Pine, Larch, Spruce, and Fir timber. (After Bauschinger.) [Compressive strength = 13,800 specific gravity — 900.]

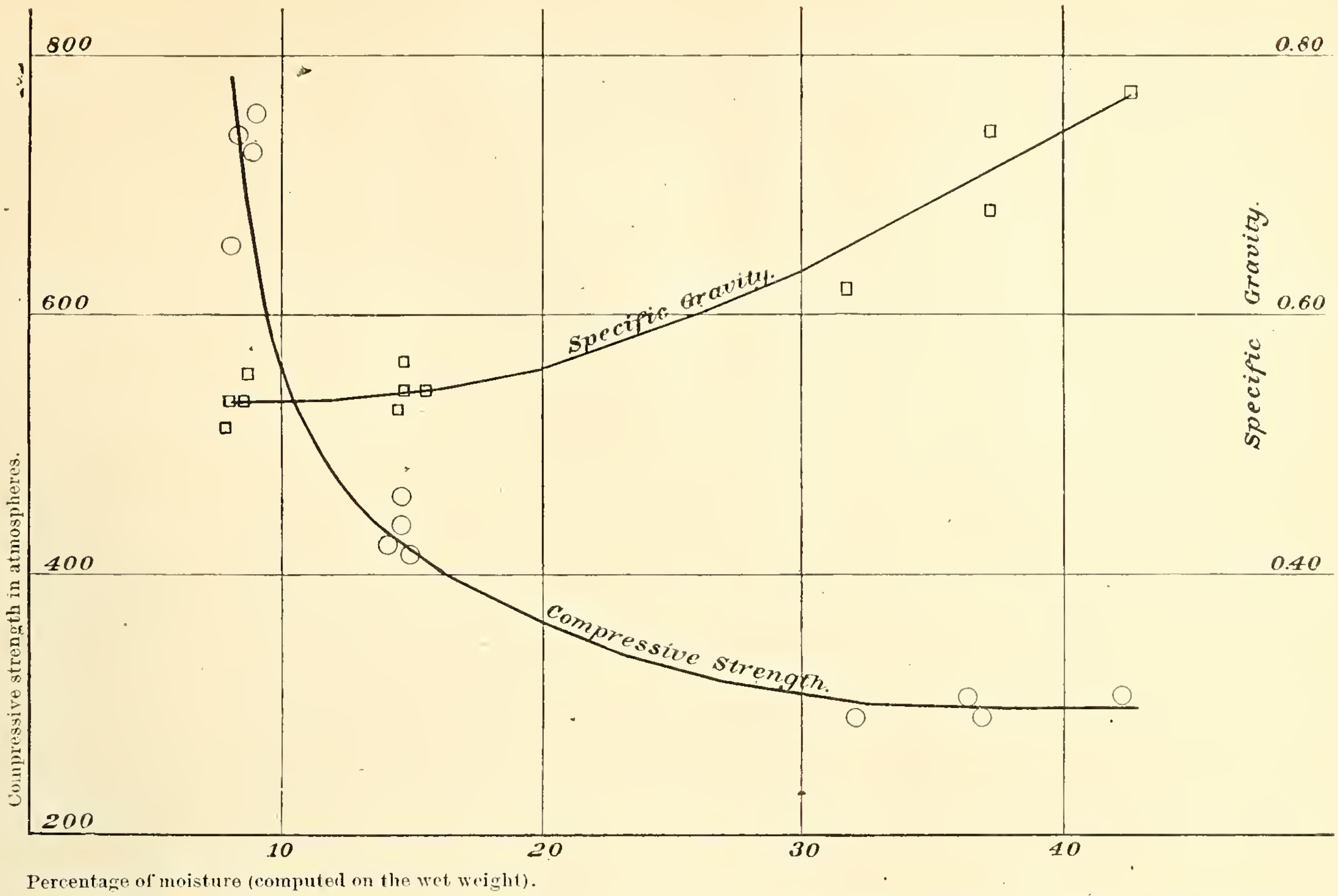


FIG. 9.—Variation of compressive strength and of specific gravity for varying percentages of moisture. Results on Scotch Pine timber. (After Bauschinger.)

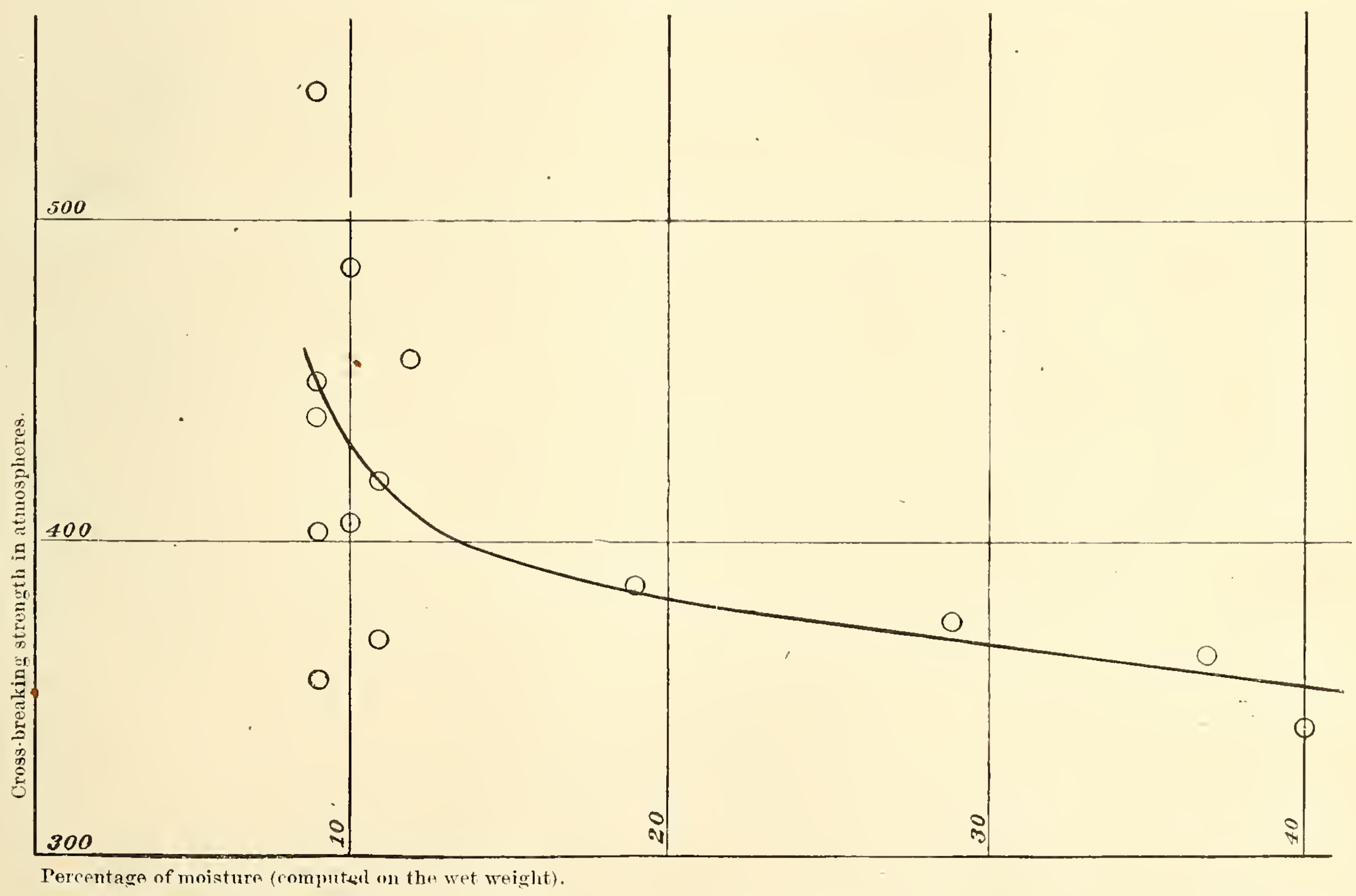


FIG. 10.—Relation between cross-breaking strength and percentage of moisture for Pine, Larch, Spruce, and Fir timbers. (After Bauschinger).

THE LONG-LEAF PINE.

(*Pinus palustris* Mill.)

BRIEF ACCOUNT OF THE SPECIES—ITS BOTANICAL AND TECHNICAL CHARACTERISTICS AND DISTRIBUTION.

[Reprint, with additions, from Annual Report of the Chief of the Division of Forestry for 1891.]

There are in the Southern Atlantic and Gulf States ten species of pine which are or can be cut into lumber. Two of these, the white pine (*Pinus Strobus* L.) and the pitch-pine, also called yellow or black pine (*Pinus rigida* Mill.) occur only in small bodies on the Allegheny Mountains from Virginia down to northern Georgia, being rather Northern pines. Three, the Jersey or scrub-pine, occasionally also called shortleaf or spruce-pine (*Pinus virginiana* Mill.) along the coast to South Carolina; the sand, scrub, or spruce-pine [*Pinus clausa* (Engelm.) Sarg.], found in a few localities in Florida, and the pond, also called loblolly or Savannah pine (*Pinus serotina* Mx.) along the coast from North Carolina down to Florida, occur either so sparingly that they do not cut any figure on the lumber market or do not often produce sizable trees for sawlogs.

There remain, then, five distinctly Southern species which are actually cut for lumber; one of these, the spruce-pine, also called cedar pine or white pine (*Pinus glabra* Walt.), probably does not reach the market except by accident. But the other four may be found now in all the leading markets of the East.

There exists considerable confusion among architects, builders, engineers, as well as dealers in lumber and lumbermen themselves, as to the identity of these species and their lumber.

The confusion arises mainly from an indiscriminate use of local names and from ignorance as to the differences in characteristics of their lumber as well as the difficulty in describing these. Besides the names used in designating different species, there are names used by lumbermen to designate differences of quality in the same species and, in addition, names used in the markets without good distinction, until it becomes almost impossible to unravel the multiplicity of designations and define their meaning. Architects are apt to specify "Southern pine," not knowing that the greatest range of qualities can be supplied under that name; or refuse to accept "Texas" or "North Carolina pine" for "Georgia pine," although the same pine and quality can be furnished from either State. Dealers handle "long-leaf pine" from Arkansas, where the timber that is understood by that name never grew. Millmen fill their orders for this pine, either overlooking differences or without knowing them.

The table (page 15) of common names, which have been found applied to the four species furnishing Southern pine lumber, will most readily exhibit the difficulty arising from misapprehension of names. These names are used in the various markets and in various localities in the home of the trees. Where possible the locality in which the name is used has been placed in brackets by the side of the name.

MARKET NAMES.

The various names under which Southern pine lumber appears in the market are either general or specific; the former being more or less general in application to lumber manufactured in the South, without reference to special localities, the latter referring to special localities from which the lumber is actually or presumably derived. In regard to the latter class of names it is

Names of Southern lumber pines in use.

Botanical names.	*Pinus palustris* Miller. Syn. *P. australis* Michx.	*Pinus cubensis* Griesebach. Syn. *Pinus Tæda* var. *heterophylla* Ell. *P. Elliotii* Engelm. *P. cubensis* var. *terthrocarpa* Wright.	*Pinus echinata* Miller. Syn. *Pinus mitis* Michx. *Pinus virginiana* var. *echinata* Du Roi. *P. Tæda* var. *variabilis* Aiton. *P. variabilis* Lamb. *P. rigida* Porcher.	*Pinus Tæda* Linn. Syn. *Pinus Tæda* var. *tenuifolia* Aiton.
Best common names. Local, market, and lumbermen's name.	LONG-LEAF PINE: Southern yellow pine. Southern hard pine. Southern heart-pine. Southern pitch-pine. Hard pine (Miss., La.). Heart pine (N. C. and So. Atlantic). Pitch-pine (Atlantic). Long-leaved yellow pine (Atlantic). Long-leaved pine (Atlantic). Long-leaved pitch-pine (Atlantic). Long-straw pine (Atlantic). North Carolina pitch-pine. Georgia yellow pine. Georgia pine. Georgia heart-pine. Georgia long-leaved pine. Georgia pitch-pine. Florida yellow pine. Florida pine. Florida long-leaved pine. Texas yellow pine. Texas long-leaved pine.	CUBAN PINE: Slash-pine (Ga., Fla.). Swamp pine (Fla. and Ala.), in part. Bastard pine (Fla., Ala.). Meadow pine (Fla., E. Miss.), in part. She pitch-pine (Ga.).	SHORT-LEAF PINE: Yellow pine (N. C., Va.). Short-leaved yellow pine. Short-leaved pine. Virginia yellow pine (in part). North Carolina yellow pine (in part). North Carolina pine (in part). Carolina pine (in part). Slash-pine (N. C., Va.), in part. Old-field pine (Ala., Miss.). Bull-pine (?). Spruce-pine.	LOBLOLLY PINE: Slash-pine (Va., N. C.), in part. Loblolly-pine (Gulf Region). Old-field pine (Gulf Region). Rosemary-pine (N. C., Va.). Short-leaved pine (Va., N. C., S. C.). Bull-pine (Texas and Gulf Region). Virginia pine. Sap-pine (Va., N. C.). Meadow pine (Fla.). Cornstalk pine (Va.). Black pine (Va.). Fox-tail pine (Va., Md.). Indian pine (Va., N. C.). Spruce-pine (Va.), in part. Bastard pine (Va., N. C.). Yellow pine (No. Ala., N. C.). Swamp pine (Va., N. C.). Long-straw pine (Va., N. C.), in part.

to be regretted, perhaps, that they have been found necessary, the more because through their use not a few misconceptions and difficulties have arisen between consumers, manufacturers, and wholesale dealers, owing to the difficulty in defining what tree species furnish lumber included by such name or names.

The uninitiated may not understand that the various kinds of pine lumber manufactured in different States, although called by a specific name, may, after all, be of the same species and the same in all respects: "Florida long-leaved yellow pine" or "Florida pine," is in no way different from that cut and manufactured in Georgia under the distinctive name of "Georgia long-leaved yellow pine," or "Georgia pine." The question as to any difference of quality dependent upon locality of growth is as yet undecided.

The market names given to the various pines, uncertain as to their precise application in the minds of those that use them, or at least at variance with the conception of other authorities, are the following:

General.—Yellow pine, Southern yellow pine, Southern pine, long-leaved yellow pine, long-leaved pine, hard pine, pitch-pine.

Specific.—Virginia yellow pine, Virginia pine, North Carolina yellow pine, North Carolina pine, Georgia yellow pine, Georgia pitch-pine, Georgia pine, Georgia longleaf yellow, Georgia long-leaved pine, Florida yellow pine, Florida pine, Florida long-leaved pine, Texas yellow pine, Texas long-leaved pine.

The names "yellow pine," "Southern pine," seem first of all to be used as generic names, without distinction as to species. In the quotations from Western markets only "yellow pine" and "long-leaved yellow pine," or "long-leaved pine" are distinguished; the first name seemingly being now always used when "short-leaf" is meant, although it is also applied by advertisers from the long-leaf-pine region to their product. In a market report of a leading lumber journal we find that "in the yellow-pine line, long-leaf, short-leaf, and curly pine can be bought," which would show that the attempt to distinguish the two kinds by their proper names is made. Curly pine, however, is in most cases long-leaf pine with a wavy or curly grain, a sort which is also found in the short-leaf species. Loblolly seems not to be quoted in the Western markets.

Formerly, while the long-leaf pine was the only pine reaching the markets, it was commonly known under the name of "yellow pine," but now the supply under this name may be made up of

all the species indiscriminately. In Texas and Louisiana "yellow pine" designates the long-leaf species, in Arkansas and Missouri the short-leaf, while there the name "long-leaf" is applied to the "loblolly," which is rarely cut.

In Florida, the Carolinas, and Georgia the name "yellow pine" is also used with less distinctive application. In Florida, besides the Cuban pine, which is never distinguished on the market, loblolly may also appear in the lumber pile. In Georgia and the Carolinas, although locally the name "yellow pine" is most frequently applied to the short-leaf, in the market a mixture of long-leaf, short-leaf, loblolly, and Cuban pine satisfies the name.

In England, where probably nothing but long-leaf pine is handled, the current name is "pitch-pine," and this name is also most commonly used in Georgia and North and South Carolina, strictly applying to long-leaf pine. In Boston only Southern and hard pine is mentioned without distinction. It is in New York, Philadelphia, Baltimore, and other Atlantic markets that the greatest variety of names is used, with an attempt to distinguish two kinds, the long-leaf and short-leaf, by using the name of the State from which the lumber is supposed to come, but neither the name nor the lumber pile agree always with the species that was to be represented.

"North Carolina pine," which is supposed to apply specifically to short-leaf, will be found to include in the pile also better qualities of loblolly, sometimes to the amount of 50 per cent. Long-leaf forms only very occasionally a part of the supplies from this section.

"Georgia pine" is meant to designate the long-leaf species, and, like "Florida pine," does mostly conform to this designation except as noted before under the name of yellow pine.

"Virginia pine" and "Virginia yellow pine" are names hardly known elsewhere than in the markets of Baltimore and Washington, where the bulk of the common building timber consists of it. It applies in the main to the loblolly, with a very small percentage of short-leaf making its way into the pile. While this is mostly coarse-grained, inferior material, selected stuff when well seasoned furnishes good finishing and flooring material.

FIELD NAMES.

Field names are those applied to the four Southern pine lumber species in the tree and logs. Such names are usually more or less known to dealers and manufacturers, but, aside from the market names already discussed, are rarely, if ever, applied to lumber in the market.

Of the three pines, long-leaf, short-leaf, and loblolly, the first alone is perfectly known by lumbermen and woodmen as a distinct "variety" (species). The remaining species, presenting to the lumberman's eye various forms according to the site producing the timber, are commonly supposed "varieties" or "crosses" more or less related to the long-leaf pine. Specific differences in the lumber, both in appearance and quality, form, however, a sufficient basis of distinction as far as lumber is concerned, although this distinction is not necessarily carried out in putting lumber on the market.

A few of the names in common use are frequently applied by lumbermen to entirely different species from those usually known to botanists by the same name. The perplexity thus arising, upon the supposition that the common names of our botanical text-books are applied to the species by lumbermen, is not inconsiderable, and can doubtless be avoided only by a more careful attention on the part of the people to real specific distinctions.

The confusion in names is such that it is almost impossible to analyze properly the use of these names in the various regions. In the above tabulated account of names a geographical distribution has been given as far as possible. Here only a few of the names are to be discussed.

"Pitch-pine" is the name most commonly applied to the long-leaf in the Atlantic regions, and where it occurs associated with the short-leaf and loblolly the former is called "yellow pine" and the latter is called "short leaf." The name "long-leaf or long-leaved pine" is rarely heard in the field, "longstraw" being substituted.

The greatest difference of names and consequent confusion exists in the case of the loblolly, due no doubt to the great variety of localities which it occupies and consequent variety of habit of growth and quality. "Swamp" and "sap-pine" refer to comparatively young growth of the loblolly, coarse grained, recognized by the rather deep longitudinal ridges of the bark, growing

on low ground. "Slash-pine" in Virginia and North Carolina is applied to old well-developed trees of both loblolly and short-leaf; in Florida it is exclusively applied to the Cuban pine. When applied to the loblolly it designates a tree of fine grain, one-half to two-thirds sap, recognized by the bark being broken into large, broad, smooth plates. This same form is also called "short-leaf pine" in North Carolina.

"Rosemary-pine" is a name peculiar to a growth of loblolly in the swamp region of the Carolinas, representing fully grown trees, fine grained, large amount of heart, and excellent quality, now nearly exhausted.

"Loblolly" or "old-field pine," as applied to *Pinus Tæda*, is a name given to the second growth springing up on old fields in North and South Carolinas, while in Alabama and Mississippi, etc., the name "old-field" pine is applied to *Pinus echinata*.

Botanical diagnosis.

Species.	*Pinus palustris* Miller.	*Pinus cubensis* Griseb.	*Pinus echinata* Miller.	*Pinus Tæda* Linn.
Leaves	3 in a bundle, 9 to 12 (exceptionally 14 to 15) inches long.	2 and 3 in a bundle; 7 to 12 (usually 9 to 10) inches long.	2 and 3 in a bundle; $1\frac{3}{8}$ to 4 inches long; commonly $2\frac{1}{2}$ to 4 inches.	3 in a bundle; 5 to 8 inches long.
Cones (open)	6 to 9 inches long; $4\frac{1}{2}$ to 5 inches in diameter.	4 to $6\frac{1}{2}$ (usually 4 to 5) inches long: 3 to $4\frac{3}{4}$ inches in diameter.	$1\frac{1}{4}$ to 2 inches long; $1\frac{1}{8}$ to $1\frac{3}{4}$ inches in diameter.	$2\frac{1}{2}$ to $4\frac{1}{2}$ inches long; $1\frac{3}{4}$ to 3 inches in diameter.
Scales	$\frac{7}{8}$ to 1 inch broad: tips much wrinkled, light chestnut brown, gray with age.	$\frac{11}{16}$ to $\frac{7}{8}$ inch broad; tips, wrinkled; deep russet brown; shiny.	$\frac{5}{16}$ to $\frac{3}{8}$ (exceptionally about $\frac{1}{2}$) inch broad; tips light yellow-brown.	$\frac{3}{8}$ to $\frac{3}{4}$ inch broad; tips smooth; dull yellow-brown.
Prickles	Very short, delicate, incurved.	Very short; straight; declined.	Exceedingly short ($\frac{1}{16}$ inch), delicate straight, declined.	Short; stout at base.
Buds	$\frac{3}{4}$ inch long; $\frac{1}{2}$ inch in diameter; silver white.	About $\frac{1}{2}$ inch long; $\frac{1}{4}$ inch in diameter; brownish.	$\frac{3}{8}$ to $\frac{1}{2}$ inch long; about $\frac{1}{8}$ inch in diameter; brownish.	$\frac{1}{2}$ to $\frac{3}{4}$ inch long; $\frac{1}{4}$ inch in diameter; brownish.

In aspect and habit the long-leaf and Cuban pine somewhat resemble each other. The large silvery white buds of the long-leaf pine, which constitute its most striking character, and the candelabra-like naked branches with brush-like tufts of foliage at the end readily distinguish it from the Cuban pine, which bears a fuller and denser crown. The dark-green, glossy, and heavy foliage of the latter readily distinguishes this again from the loblolly, where these may appear associated, the latter having sea-green and thinner foliage.

As a rule, the Cuban pine grows taller (up to 110 or 115 feet, with a diameter of $2\frac{1}{2}$ to 3 feet) than the longleaf, which rarely exceeds 105 feet and 20 to 36 inches in diameter. The Cuban pine forms massive horizontally spreading limbs, and at maturity a crown with rounded outlines; the long-leaf pine forms a more flattened crown with massive but twisted, gnarled limbs, which are sparingly branched.

The thin bark of the long-leaf (only one-quarter to one-half inch thick), of uniform reddish brown color throughout, exfoliates in thin, almost transparent, rhombic flakes; the thick bark of the Cuban pine of the same color exfoliates in very thin, broad, purplish flakes.

The short-leaf pine is readily distinguished by the comparatively shorter and more scant appearance of its foliage. Moreover, this species is at once recognized by its characteristically small cones. Its habit is spreading, if compared with the more ascending, compact habit of the loblolly. At maturity the short-leaf has a much shorter bole (85 to 95 feet, diameter $1\frac{1}{2}$ to 2 feet) than the loblolly (125 to 150 feet, diameter 4 to 5 feet), with which it is often associated, and a more pyramid-shaped crown.

The reddish bark of the short-leaf in mature trees is broken into long plates, while the loblolly bark appears of grayish color and breaks into broader, larger, and more deeply fissured plates.

DISTRIBUTION AND HABITAT.

The geographical (botanical) distribution of the long-leaf pine is shown in a map published in the annual report of the chief of the forestry division for 1891, which was prepared by Dr. Charles Mohr, of Mobile, Ala., agent of this division, and much of the information here given, is taken from his still unpublished monographs on these pines.

Within the boundaries of geographical distribution each species is found to occupy certain soils and sites which form its habitat. The habitat of the pines in general is found on sandy and

mostly well-drained soils. In regard to moisture conditions of the soil, the different species adjust themselves differently. The long-leaf pine is found (only exceptionally otherwise) on the best-drained, deep, sandy, siliceous alluvium, while the Cuban pine is confined to the moister flats or pine meadows of the coast, and will grow closely down to the sandy swamps; not objecting to clayey admixtures in the soil, but shunning the dry sandy pine hills. The short-leaf pine prefers a well-drained, light, sandy or gravelly clay soil, or warm light loam, while the loblolly, often struggling with the short-leaf for the possession of the soil, can adapt itself to wetter situations.

From the southern confines of Virginia the long-leaf pine covers the later deposits of sands, light loams, and gravel which follow the Atlantic coast to the everglades of Florida, and west on the gulf shore to the valley of the Trinity River (Texas), in a belt from 60 to 150 miles wide. In northern Alabama and the adjoining part of Georgia the forests of this pine reach a short distance beyond the 34° north latitude on isolated and more or less restricted areas in similar soil. In its distribution through the Atlantic States and the eastern Gulf region, three distinct divisions can be recognized in this coast pine belt: First, the coast plain, from 10 to 30 miles from seashore, rising above the marshes and alluvial swamps, forms a belt 5 to 30 miles in width. In the grassy flatwoods this pine is found scattered and of rather stunted growth, while on the higher level, where it once prevailed in greater perfection, it has been largely replaced by the loblolly and the Cuban pines.

The second division embraces the rolling pine lands or pine barrens proper, the elevation of which is rarely over 250 feet above tide water. These undulating lands often spread out into extensive table-lands, and are, almost without any interruption, covered with a pure growth of mature long-leaf pine of the greatest perfection.

The third division, forming the upper part of the maritime pine belt, is a region of mixed growth, where on the steep rocky or gravelly ridges the longleaf pine is frequently associated with the short leaf and loblolly pine and hardwood trees. In this division, generally on a richer soil, the long leaf pine attains a greater size with a larger number of full-sized trees to the acre. The long-leaf timber of this division generally shows a larger proportion of sapwood and a slightly coarser grain than that of the other divisions, and has therefore been considered somewhat inferior in quality. It is found more generally wind-shaken.

In Virginia the long-leaf pine is, for all practical purposes, extinct. In North Carolina, in the division of mixed growth and in the plain between the Albemarle and Pamlico Sound, the long-leaf pine has likewise been almost entirely removed and is replaced by the loblolly. The forests of longleaf pine begin with Bouge Inlet, stretching for a distance of from 95 to 150 miles inland, reaching down to the State line and cover, roughly estimated, about 6,500,000 acres. These forests have been to a great extent despoiled of their timber wealth by the tapping of the trees for turpentine.

From the statement of the Tenth Census Report the timber supply of long-leaf pine in South Carolina is but slightly exceeded by that of North Carolina. The pine belt in this State is about 150 miles wide. It is mainly occupied by the long-leaf pine, but on the hill lands is intermixed with the short-leaf pine. The forests on the elevated table-land in the southwestern part of the State, almost untouched, are spoken of as being of the finest quality. It is interesting to note that there has been during the past ten years a steady increase in the development of the lumber resources of the State. In Georgia, the great pine State of the southern Atlantic, the forests of long-leaf pine cover, almost exclusively, the vast interior plain of over 17,000 square miles in extent. The timber from this extensive lumbering region (in the markets favorably known as "Georgia pine") is mostly rafted down the Savannah River and the Altamaha River to Savannah, Darien, and Brunswick. During the past twelve years shipments aggregating about 300,000,000 square feet of lumber and square timber have been made annually from these ports, with but slight fluctuations in the amount of the annual outputs. In eastern Florida the pine belt can be traced to St. Augustine. Farther south, the long-leaf pine is replaced by the Cuban pine. On the Gulf side more important areas of the long-leaf growth are found extending until the savannas and everglades are reached, where again the Cuban pine replaces it, but the timber seems to be of an inferior quality and the pine forests are frequently interrupted by swamps with hardwood trees. Since 1880 the lumbering industry in eastern Florida has been on the decline.

In the Gulf States, from the Chattahoochee River to the lowlands of the Mississippi, the pine belt covers about 40,000 square miles. The forests of long-leaf pine in western Florida have been largely exhausted. The most extensive and finest bodies remaining are found between the Perdido and Escambia rivers toward the Alabama State line and in some of the remoter townships along the same border further east to the Yellow River.

In Alabama the best and largest supplies of long-leaf pine timber are found in the forests of undulating pine lands between the Chattahoochee Valley and Perdido River. Over one-third of the timber and lumber annually shipped from Pensacola, amounting on the average for the last five years to about 250,000,000 feet, is derived from these forests. The high quality of their timber is strikingly exhibited in the quantities of hewn square timber exported from the above port and from Mobile to England and Europe. At present Mobile is meeting the highest requirements in this line of export trade, furnishing sticks without a blemish of 120 cubic feet on the average. During the past year 2,903,000 cubic feet of hewn square timber has been shipped from this place. In the upper division of the coast pine belt, or region of mixed growth, the forests of long-leaf pine are confined to the steep gravelly or rocky ridges and can be said to cover about 7,000 square miles; where the long-leaf pine is found either alone or associated with the short-leaf, the loblolly pine, and hardwood trees. The growth is heavy, the trees generally ranging between 20 and 25 inches in diameter, breast high; they are from 200 to 250 years old, and for the greatest part found to be wind-shaken, a result, no doubt, of a freer exposure to the force of the wind. The forests of long-leaf pine crossing the State centrally in a belt from 5 to over 20 miles wide and covering a little over 1,000 square miles, and those of lesser extent found in the northern half of the State, furnish timber not inferior to that from the rolling pine lands of the maritime belt. The drift deposits along the Coosa River, covering about 300,000 acres, and a detached portion of drift in Walker county of 60,000 acres, is covered with pine of fine quality hardly yet touched. The forests of long-leaf pine in Mississippi in their extent fall but little short of those in Alabama, and are fully equal in the quality of their timber; not less than 300,000,000 feet of timber and lumber have been shipped by water and rail from the mills along the Pascagoula and Pearl rivers and the New Orleans, Northeastern, and Illinois Central Railroad lines.

During the year 1892 fully 751,000,000 feet of timber and lumber have been shipped to foreign and domestic markets from the coast pine belt of the Gulf States east of the Mississippi River. Toward the west, in Louisiana, the coast pine belt gradually passes into a mixed growth of short-leaf pine, oaks, and hickories on the uplands bordering the Mississippi. The slightly undulating flatwoods of Louisiana support a better timber growth than is generally found in the upland pine barrens; but this forest has been largely invaded, while the pine-hill region of Louisiana has remained almost untouched. The pine region west of the Mississippi River, limited to the sands and gravels of the region, follows on its eastern boundary the valley of the Ouachita River for 150 miles.

In the center of the region above the Red River pine ridges alternate with tracts of oak and hickory.

In western Louisiana and eastern Texas the forests of the long-leaf pine occupy, roughly estimated, an area somewhat exceeding 10,000 square miles. The pine lands north of the Red River are undulating and differ in no way in the nature of their timber growth from similar lands in the coast pine belt of the eastern Gulf States. South of the Red River the rolling lands merge into flat woods which, from Lat. 31° N. continue from the basin of the Calcasieu River without change across the Sabine River to the valley of the Trinity River in Texas. These flat woods of southwestern Louisiana and eastern Texas support a denser timber growth, said by experts to frequently exceed 7,000 square feet to the acre. The trees are for this species of a remarkably quick growth. As observed in the forests near the Natchez River in Texas, full-sized trees from 23 to 25 inches in diameter, breast high, showed from 208 to 340 rings respectively on the stump; and trees from 19 to 21 inches in diameter show 105 and 113 annual rings; trees of this stage of growth show, on a radius of from $9\frac{1}{4}$ to $9\frac{6}{8}$ inches (clear of bark), 4 inches of sap. In the mature trees mentioned first the thickness of sap was found in the first instance $2\frac{1}{2}$ inches on a radius of 13 inches and in the second $1\frac{1}{3}$ inches on a radius of nearly 11 inches. The grain is coarser and even, and the timber remarkably free from the defects caused by wind shaking. Nearly all of the

timber of these western forests of the long-leaf pine is sawn into lumber and square stuff, used for framing and car building, and shipped to the northern markets to supply the timberless regions of the west. During the past year the cut has been ascertained to fall not far short of 800,000,000 feet board measure. Of this output 225,000,000 square feet have to be ascribed to Louisiana and 575,000,000 to Texas.

CHARACTERISTICS OF THE WOOD.

No more difficult task could be set than to describe on paper the wood of these pines, or to give the distinctive features so that the kinds can be distinguished and recognized by the uninitiated. Only the combined simultaneous impressions upon all the senses permit the expert to make sure of distinguishing these woods, without being able to analyze in detail the characters by which he so distinguishes them. While in many cases there would be no hesitation in referring a given stick to one or the other species, others may be found in which the resemblance to more than one species is so close as to make them hardly distinguishable. The following attempt to diagnose these woods must, therefore, be taken only as an imperfect general guide. So far even microscopic examination has not furnished unfailing signs. Color is so variable that it can hardly serve as a distinguishing feature. The direction of the cut, roughness of surface, exudation of resin, condition of health, width of grain, moisture condition, even the mode of drying, exposure, etc., all have their share in giving color to the wood. Bearing in mind this great complication of color effects, it will be granted that descriptions of the same, disturbed by peculiarities of each separate observer, will aid but little in identifying the woods.

The sapwood of all the pines looks very nearly alike, and so does the heartwood. The color of the springwood in the sap is a light yellowish with a shade of brown; the summer wood contains more brown, variable with the density of the cells and appearing darker when the bands are more abruptly separated from the spring wood. The heart-wood shows a markedly darker color with a reddish flesh-color tinge added.

It is perhaps easiest to distinguish the wood of the long-leaf and Cuban pines from that of the short-leaf and loblolly. It is also possible to keep apart the long-leaf from the Cuban; but while, in general, the short-leaf and loblolly can be more or less easily distinguished by color or grain, some forms of the latter (rosemary-pine) so nearly resemble the former that no distinguishing feature is apparent.

The most ready means for distinguishing the four seems to be the specific gravity or weight in connection with the grain. The proportion of sap and heart-wood will also be an aid in recognizing a log or log-run lumber in the pile. These distinctive features are tabulated as follows, the figures representing average conditions of merchantable timber and mature trees:

Diagnostic features of the wood.

Name of species.		Long-leaf pine (*Pinus palustris* Miller).	Cuban pine (*Pinus cubensis* Griseb.).	Short-leaf pine *Pinus echinata* Miller).	Loblolly pine (*Pinus Tæda* Linn.).
Specific gravity of kiln-dried wood.	Possible range.	.58 to .90	.65 to .84 (Sarg.)	.39 to .76	.38 to .61
	Most frequent range.	.60 to .70	....	.50 to .60	.43 to .48
Weight, pounds per cubic foot, kiln-dried wood.	Possible range.	44 to 52	38 to 50	36 to 44	31 to 36
	Average.	48	47	40	34
Character of grain seen in cross section.		Fine and even; annual rings uniformly narrow throughout; not less than 8 (mostly about 18–25) rings to the inch.	Variable and coarse; rings mostly wide; from 6 to 8 rings to the inch.	Very variable; medium, coarse; rings wide near heart, followed by zone of narrow rings; not less than 4 (mostly about 10) rings to the inch.	Less variable, mostly very coarse; 3 to 12 rings to the inch; generally wider than in short-leaf.
Color, general appearance....		Even dark reddish-yellow to reddish-brown.	Dark straw color with tinge of flesh color.	Yellowish-red	Whitish to brownish-yellow; the dark bands of summer wood being proportionately narrow.
Sapwood, proportion.........		Very little; rarely over 2 to 3 inches of radius.	Nearly one-half of the radius.	Commonly over 4 inches of radius.	Very variable, $\frac{1}{3}$ to $\frac{1}{2}$ of the radius.
Resin.......................		Very abundant; tree turning into "light wood;" pitchy throughout.	Abundant, sometimes yielding more pitch than long-leaf; not turning into "light wood."	Moderately abundant, least pitchy; only near stumps, knots, and limbs.	Abundant; more than short-leaf, less than long-leaf and Cuban.

The long-leaf pine, then, is best distinguished by the following four characteristics:

(1) Width of the annual rings, having usually from 18 to 25 rings to the inch, as against 11 to 12 in the short-leaf and loblolly. Fewer rings to the inch would lend countenance to the suspicion that the material is not long-leaf.

(2) Weight, which for partially seasoned wood averages about 48 pounds, being 8 to 12 pounds heavier than short-leaf and loblolly. The lowest specific gravity found by Prof. Johnson was 0.66 for tree 52, or 38 pounds.

(3) Amount of resin, which produces, when the wood is cut across the grain with a sharp knife, a polished and vitreous or horny appearance of the summerwood. This is, however, not a very reliable sign, as other pines react in the same manner. Whether the presence of large amounts of resin account for the great weight and for superior strength is still an open question.

(4) Thickness of sap-wood, which, at least in the pines now cut for lumber, is rarely over 2 or 3 inches wide, much less than the other pines with which it might be confounded.

SPECIAL ADAPTATIONS OF LONGLEAF YELLOW PINE.

In regard to the use of this timber, Prof. Johnson makes the following statements regarding the extensive tests here reported.

The long-leaf pine timber is specially fitted to be used as beams, joists, posts, stringers in wooden bridges, and as flooring when quarter-sawed. It is probably the strongest timber in large sizes to be had in the United States. In small selected specimens, other species, as oak and hickory, may exceed it in strength and toughness. Oak timber, when used in large sizes, is apt to be more or less cross-grained, knotty, and season-checked, so that large oak beams and posts will average much lower in strength than the long-leaf pine, which is usually free from these defects. The butt cuts are apt to be wind-shaken, however, which may weaken any large beams coming from the lower part of the tree. In this case the beam would fail by shearing or splitting along this fault with a much smaller load than it would carry without such defect. These wind shakes are readily seen by the inspector, and sticks containing them are easily excluded, if it is thought worth while to do so. For highway and railway wooden bridges and trestles, for the entire floor system of what is now termed "mill" or "slow-burning" construction, for masts of vessels, for ordinary floors, joists, rafters, roof-trusses, mill-frames, derricks, and bearing piles; also for agricultural machinery, wagons, carriages, and especially for passenger and freight cars, in all their parts requiring strength and toughness, the long-leaf pine is peculiarly fitted. Its strength, as compared to that of short-leaf yellow pine and white pine is probably very nearly in direct proportion to their relative weight, so that pound for pound all the pines are probably of about equal strength. The long-leaf pine is, however, so much heavier than these other varieties that its strength for given sizes is much greater.

A great many tests have now been made on short-leaf and on loblolly pine, both of which may be classed with long-leaf as "Southern yellow pine," and from these tests it appears that both these species are inferior to the long-leaf in strength in about the ratio of their specific gravities. In other words, long-leaf pine (*Pinus palustris*) is about one-third stronger and heavier than any other varieties of Southern yellow pine lumber found in the markets. It is altogether likely that a considerable proportion of the tests heretofore made on "Southern yellow pine" have been made on one or both of these weaker varieties.

RESULTS OF MECHANICAL TESTS.

By J. B. Johnson.

GENERAL SUMMARY.

In Table I are given the principal results of tests on the individual sticks of long-leaf pine, made in 1891 and 1892. They comprise tests on twenty-six trees, all from Alabama. Ten of these were normal, healthy, living trees, from two localities, averaging about two hundred years old and about 21 inches in diameter. Sixteen of them had been tapped for turpentine ("boxed"), eight of them being taken from an orchard abandoned five years, and eight from an orchard recently boxed. These trees averaged 18 inches in diameter. The logs from the unboxed trees were cut into both large and small beams. Those from the boxed trees were cut wholly into four by four inch sticks. There have been about 430 tests made on these sticks in each of five ways, or some 2,150 tests in all. These tests may be divided in general into two classes, "green" and "dry." The green tests on the unboxed trees were made some six months after sawing, while those on the boxed timber were made some two months after sawing. The dry tests on the unboxed timber were made about eighteen months after sawing, and the dry tests on the boxed timber some fourteen months after sawing. Some of the dry tests were made on sticks which had been treated for a few days in a dry kiln which was operated by an exhaust fan drawing air over steam coils, the temperature of the box being less than 100° F.

The bold-faced type in this table indicates the experimental values reduced for 15 per cent moisture. This is about the ordinary percentage of moisture of seasoned lumber, under shelter, but out of doors. These are the values which have been used in all the subsequent studies and in Tables II, III and IV.

VARIATION OF STRENGTH WITH MOISTURE.

In Plates VII–X are shown the curves which exhibit the variation of strength due to difference in moisture of the test piece. No curves are given for specific gravity or for tensile strength, as both of these properties seemed to be practically independent of moisture, as shown in Plates XI and XII. The curves in Plates VII–X were obtained as follows: The average of observed results of tests on specimens from single trees were first plotted on cross-section paper, with their corresponding percentages of moisture, the several mean results (green and dry) on one tree being joined by straight lines to indicate that they all belonged to one and the same tree. These results scattered widely, since all other sources of strength entered into the result, aside from moisture. A provisional curve was then drawn, showing the probable law of change of strength due to moisture conditions alone, and this curve was then traced off upon another sheet. The several pairs of mean observed results on single trees (green and dry) were now copied upon this sheet in their true moisture relations, but without any reference to their absolute strength relation, any further than that they were made symmetrical horizontally (strength coördinate) with the assumed curve already drawn. That is to say, each pair of results (green and dry) were moved horizontally until they became symmetrical in a horizontal direction with this curve. Thus, while their relative strength was left the same, their absolute strength was ignored. In this way all other sources of influence upon strength were eliminated except that of moisture, and the law of variation of

strength with moisture was developed entirely free from other influences. In many cases a second assumed curve was drawn and a new diagram of results obtained. (Fig. 11.)

Notwithstanding this method of elimination of other sources of strength it was found in several instances, as in the modulus of elasticity, crushing across the grain, and in shearing (Plates VIII, IX, and X), that some of the trees showed such discrepancies in their relation of strength to moisture, that the curve of mean values could not be used for reducing results on these trees. Such discrepant sets of results are inclosed by dotted lines, and separate curves of correction

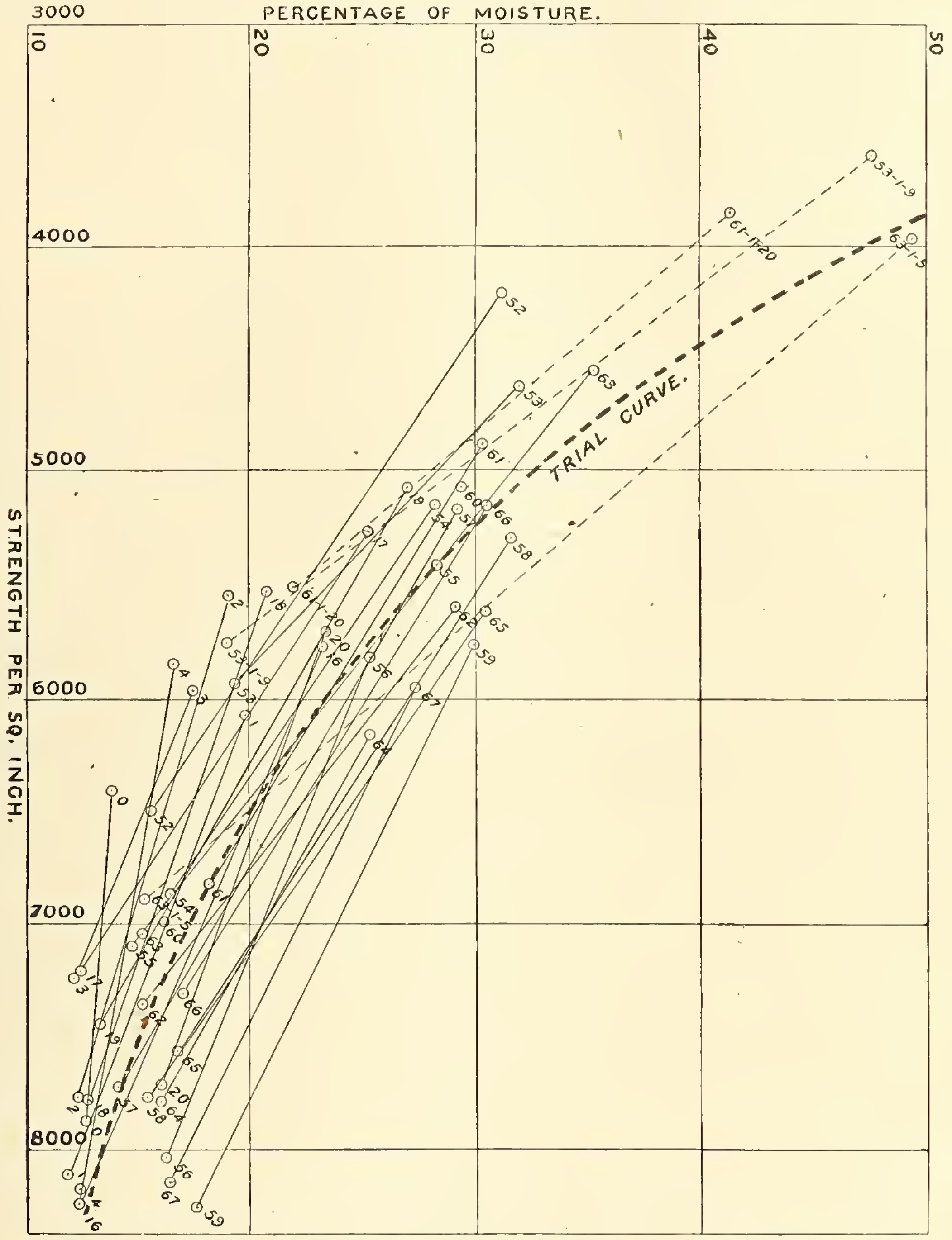


FIG. 11.—Method of constructing curves of averages. Long-leaf pine (*Pinus palustris*).

employed in these cases. The corresponding pairs (dry and green) of curves for these trees can be identified by the attached numbers of the trees, the average values for which are represented by the plotted points.

On those sticks which were originally 18-feet long beams three sets of results were obtained by tests at approximately 30, 20 and 12 per cent moisture. The very high percentages of moisture shown in all these curves do not represent averages for the tree, but represent the mean results from such sticks as had a very high proportion of moisture in the green tests. They are inserted to give some further indication of the form of this end of the curve.

EFFECT OF MOISTURE.

It will at once be evident from a casual inspection of these curves that all kinds of strength (except tensile strength, which seems to be independent of moisture) increase greatly as the moisture diminishes, and that this increase becomes very rapid after the timber has become, say, half dry, or below 20 per cent moisture. Not only is the timber stronger, but it is more elastic. Thus the gain in relative elastic resistance between 30 and 15 per cent of moisture is by a much greater proportion than the corresponding gain in the elastic-limit strength. The modulus of elasticity is also greater, so that we may say that the drier the timber (within practical limits) the stronger, the stiffer, and the tougher it becomes.

Since the specific gravity does not appreciably change as the timber dries out from 30 to 15 per cent of moisture (computed on the dry weight), it follows that the shrinkage in volume is practically equal to the diminution of moisture, so that the weight of unit volume remains practically constant in this species of timber.

RELATION BETWEEN STRENGTH AND STIFFNESS.

On Plate X are platted the average values of the moduli of elasticity for whole trees and of the moduli of cross-bending strength at the elastic limit. The relation of these two curves represents the relation which exists between the working strength and stiffness of a beam. It appears that the stiffness is a true index of the strength, and that in this species the stiffer the beam the stronger it will prove. The equation of the mean line as drawn on this plate is—

$$\textit{Elastic-limit modulus of strength in cross-breaking} = 500 + 0.0047\,E \qquad (1)$$

Where E = modulus of elasticity as found from a cross-bending test by making

$$E = \frac{Wl^3}{4\Delta bh^3} \quad . \quad . \quad . \quad . \quad . \qquad (2)$$

Where W = concentrated load at center of beam.

l = length of beam.

Δ = deflection of beam under load W.

b = breadth of beam.

h = height of beam.

All dimensions being in inches and the load in pounds.

RELATION BETWEEN STRENGTH AND SPECIFIC GRAVITY.

Plate XI exhibits the relation found to exist between crushing strength and specific gravity or weight. Assuming this curve to be a parabola, its equation would be—

$$\textit{Endwise crushing strength} = 4{,}000 + 6{,}300\ \sqrt{\text{Sp. Grav.} - .47} \quad . \quad . \qquad (3)$$

The diagram (Fig. 12) shows the relation between the "average quality" of the timber and its specific gravity. In this case each quality was represented by a percentage of its own average, and then the average of all those percentages was taken as "average quality" of each tree in comparison with the "average quality" of all other trees. Here, also, a regular increase in average strength with an increase in specific gravity is indicated. It was to be presumed that this would be the case, when the results are all reduced to a standard dryness, since then the weight per unit volume is a true measure of the amount of woody fiber and resinous matter in the timber, and those in the same species determine to some extent the strength.

RANGE OF INDIVIDUAL RESULTS AS COMPARED WITH THE AVERAGE OF ALL.

In Fig. 13 is shown a series of curves which indicate the number of results of each kind of test falling within given limits. Thus, the most accordant results were those of the endwise crushing tests, over one third of which (150 in 430) fell between 95 per cent and 105 per cent of the mean of all, while none of them fell below 60 per cent or above 140 per cent of the mean, whereas in

tension only 270 tests fell between 75 per cent and 125 per cent of the mean, while some fell as low as 25 per cent and some were as high as 190 per cent of the mean.

The greater uniformity of the tests in compression can be explained by the fact that in this case some ten square inches were always under test, whereas in tension only about one square inch was under test.

If but a single test is to be made of timber, the compression endwise gives the best indication of the general value of the wood.

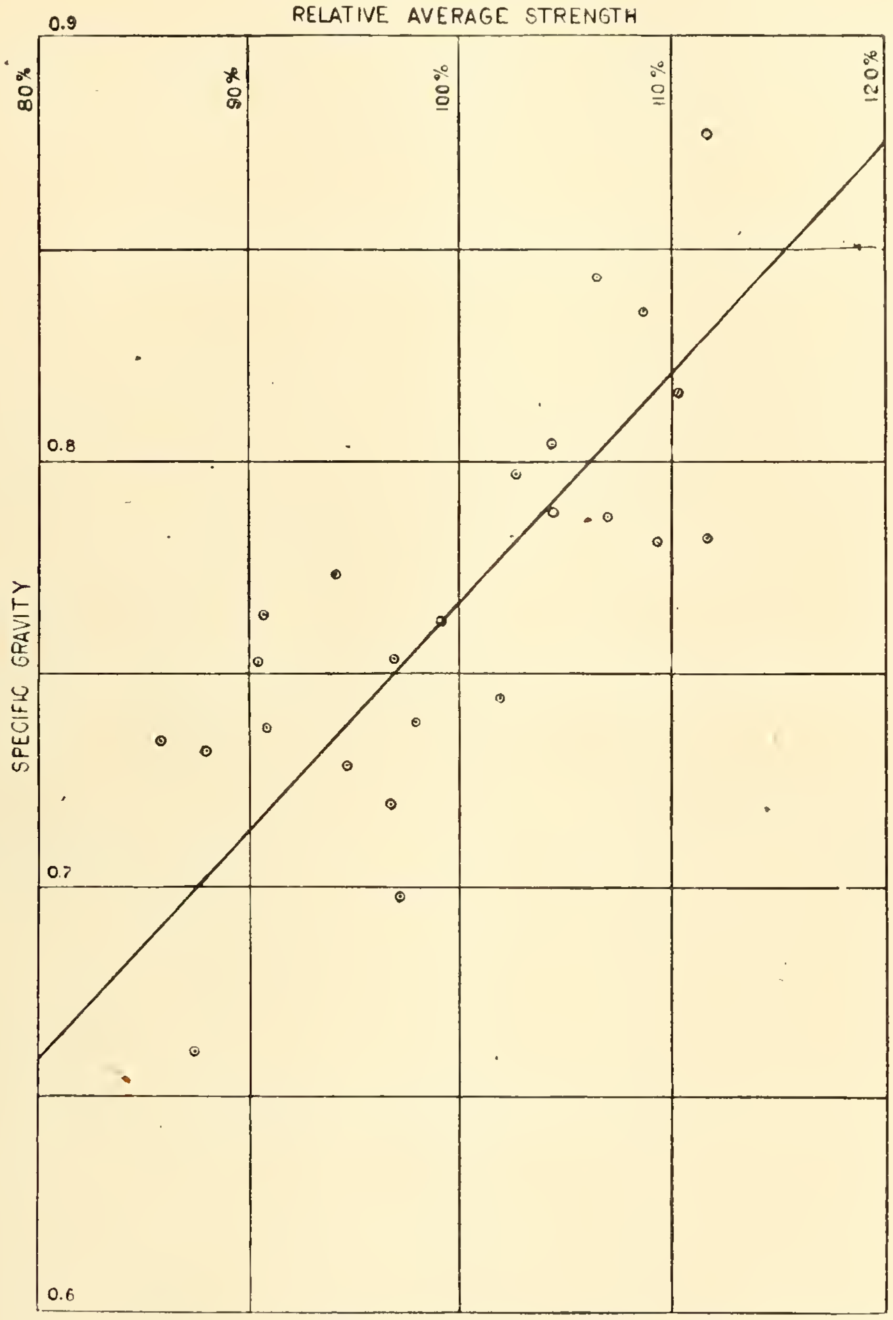


FIG. 12.—Diagram showing the relation between strength and weight when reduced to a standard dryness of 15 per cent moisture. Long-leaf yellow pine (*Pinus palustris*).

VARIATION IN STRENGTH OF DIFFERENT TREES.

The accompanying diagram (Fig. 14), showing the variation in strength of different trees, has been made up from the results recorded in Table III. This table gives in bold-faced type the mean results of all tests on specimens taken from the first 20 feet of the tree (butt). The light-faced type gives the percentage which each result is of the mean of all. The average of these percentages

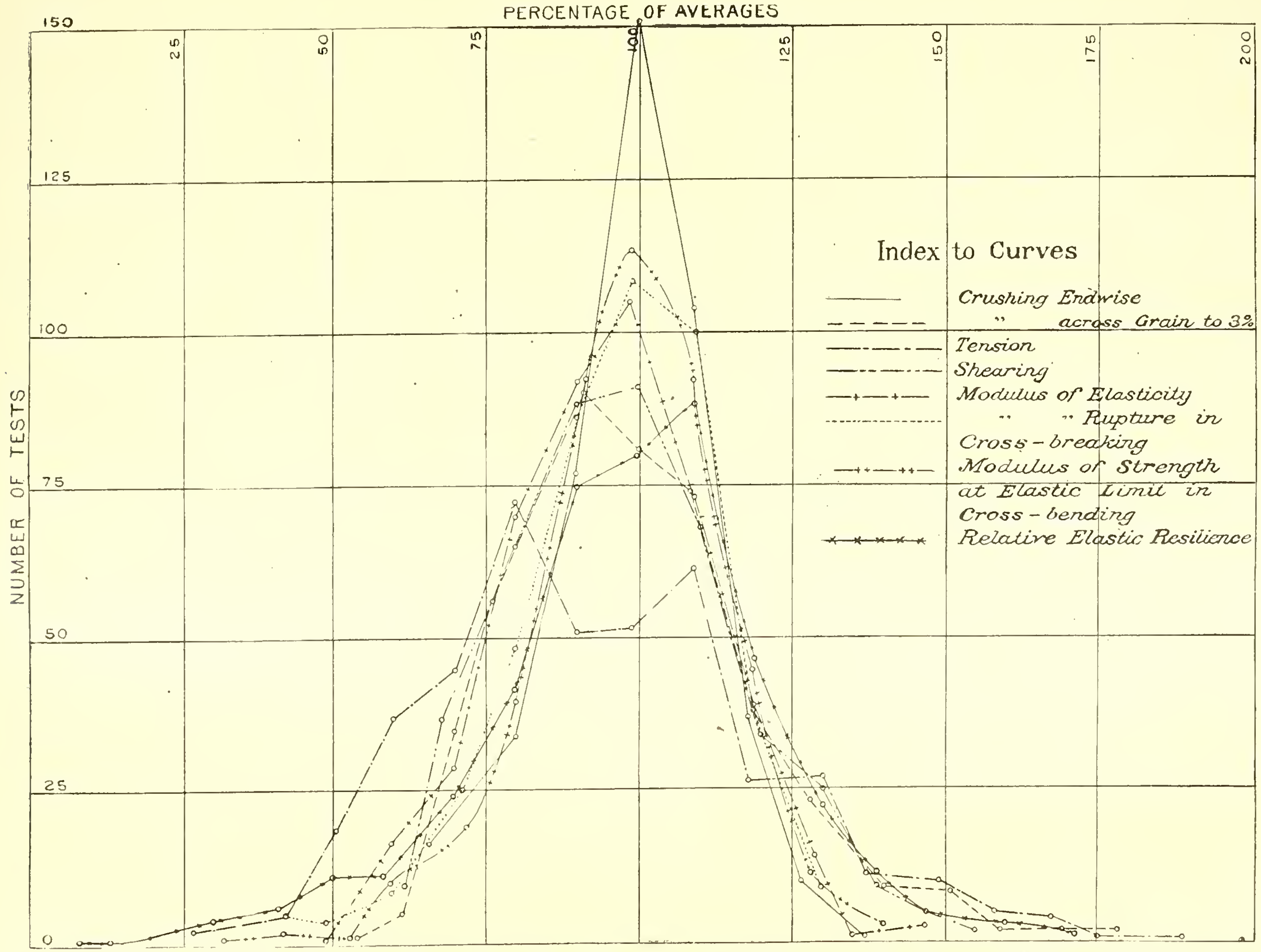


FIG. 13.—Diagram showing the range of individual results, in all kinds of tests, in terms of the percentage of the average, of 430 tests on several specimens: Long-leaf pine (*Pinus palustris*).

for any one tree, given in the last column of Table III, represents an average percentage of all qualities, or it may be considered an indication of the *relative average quality*. These averages have been used in plotting the accompanying diagram, in the order of their magnitude. No attempt is made here to explain the apparent discrepancy of 26 per cent between the lowest and highest average quality, any further than to call attention to the fact that in a general way this variation in strength corresponds fairly well with the variation in specific gravity.

COMPARISON OF SINGLE QUALITIES WITH THE AVERAGE QUALITY.

While the relations which exist between the relative average quality of a tree and its relative standing in specific gravity, compressive and cross-breaking strength (exhibited in Fig. 14), all agree, in a general way, with those trees which give less values in one of these directions having less

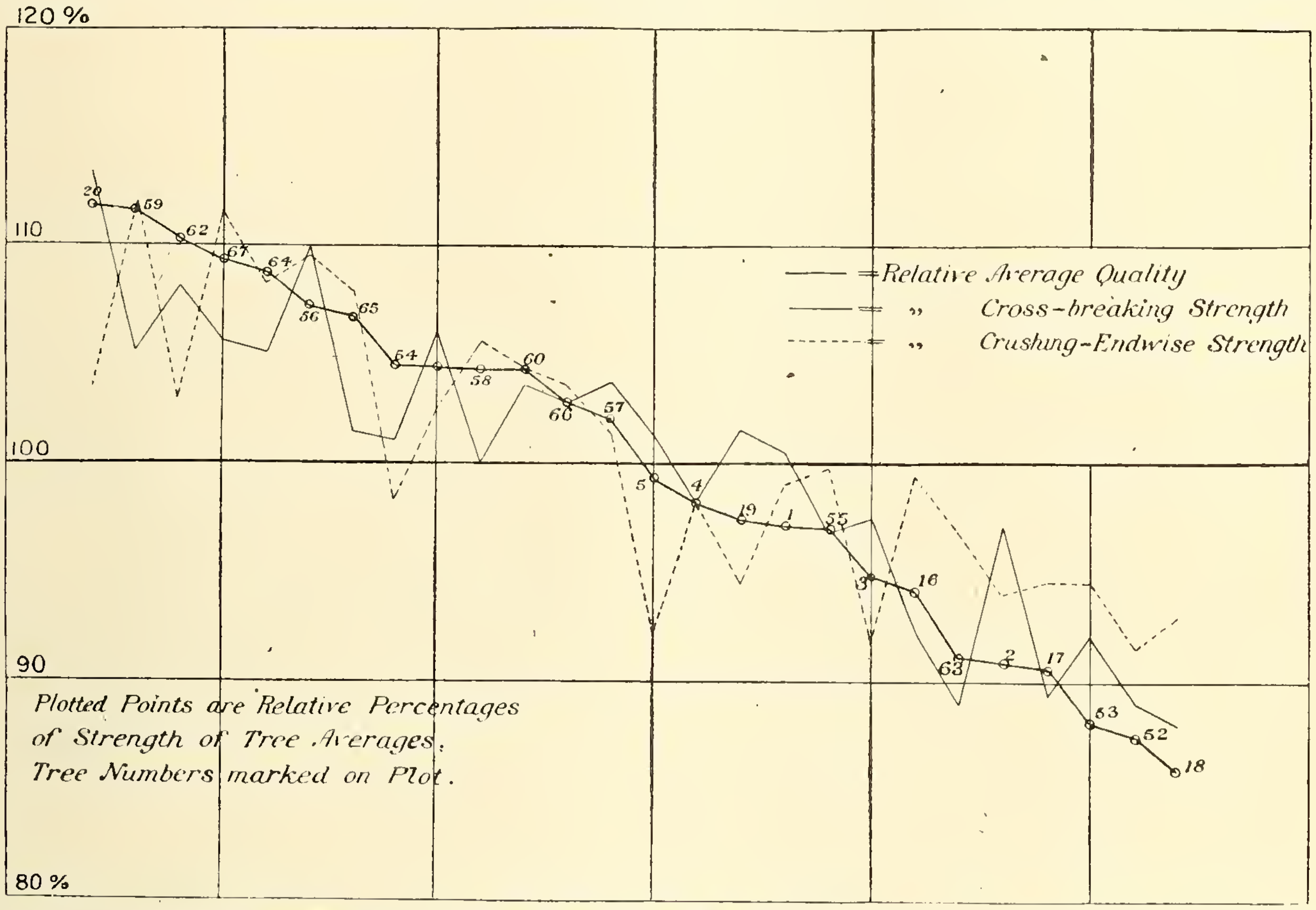


FIG. 14.—Relative average quality of different trees as compared with strength in cross-breaking and crushing endwise. Long-leaf pine (*Pinus palustris*).

values in all the others here named. In some other matters the agreement is not so close, as may be found by plotting the corresponding percentages given in Table III upon this figure. It has been well established that strength is no function of the width of the annual rings. It is, however, a function of the proportion of summer wood to spring wood in each annual ring, or, since the summer wood is always more dense, this is the same as saying that the strength is a function of the density or of the specific gravity, which relation is clearly shown in Fig. 14, as well as in Plate XI.

RELATIVE STRENGTH OF LARGE AND SMALL BEAMS.

In Table IV the mean results of all tests on large and small beams are tabulated separately. By comparing these mean values, as given at the bottom of Table IV, we are forced to conclude—

(1) That large beams are from 10 to 20 per cent weaker in ultimate strength than the corresponding 4×4 inch beams from the same logs.

(2) That large beams are stronger at their elastic limits than the small beams from the same logs.

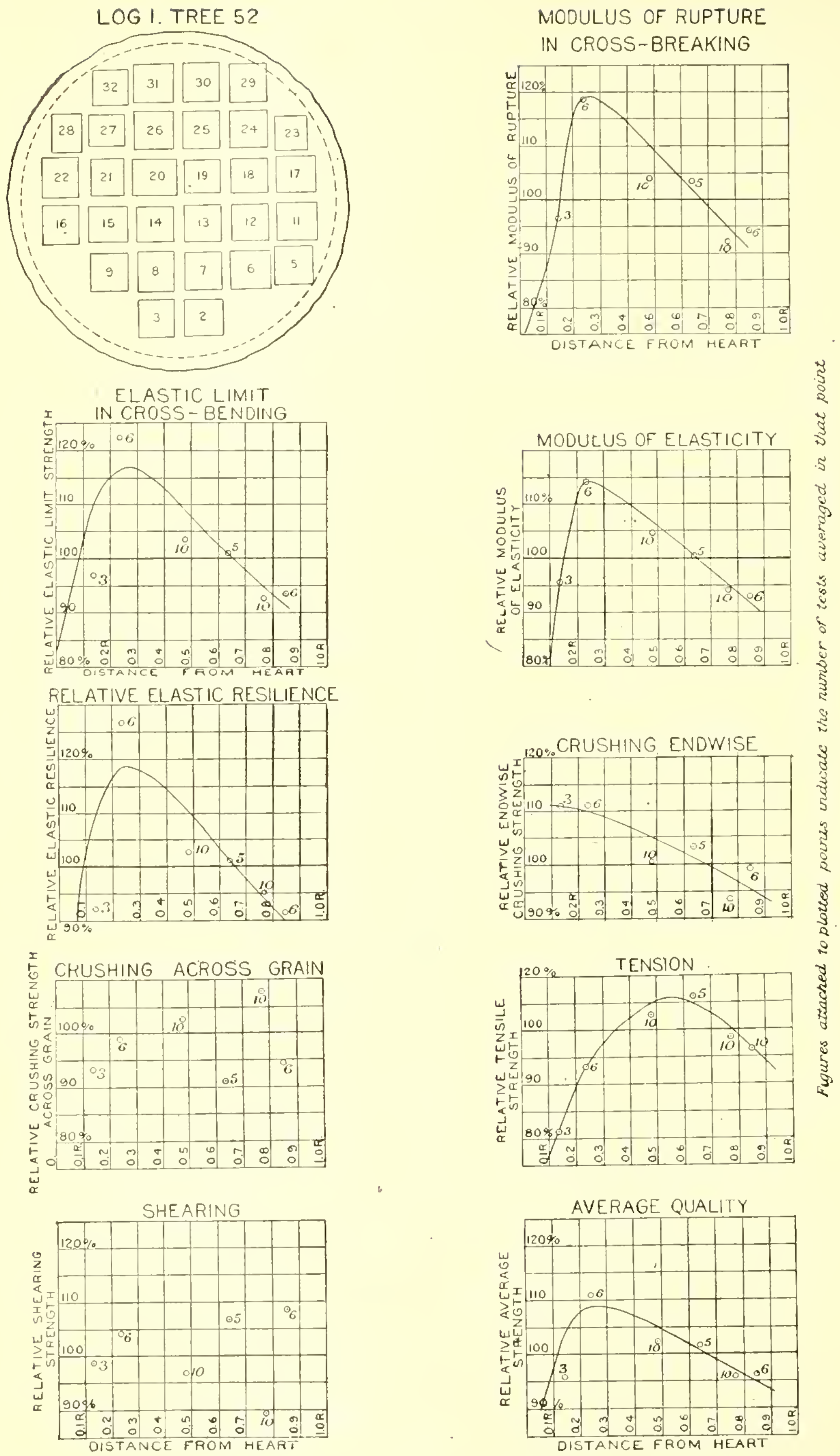


FIG. 15.—Results of tests on 4″x4″ sticks from log 1, tree 52, *Pinus palustris*, showing variation of strength across-section of log. Long-leaf pine (*Pinus palustris*).

(3) That large beams are stiffer in proportion to their size than the small beams. In other words, the modulus of elasticity as determined from a large beam is greater than that determined from a 4-inch square beam from the same log.

Caution: It must be borne in mind that the number of tests on large sticks here offered in evidence is too small to base much of an argument upon; also that, as shown by the log diagrams in Table IV, the 4-inch beams were taken from nearer the sapwood than the large sticks, and this alone may fully explain all the differences found.

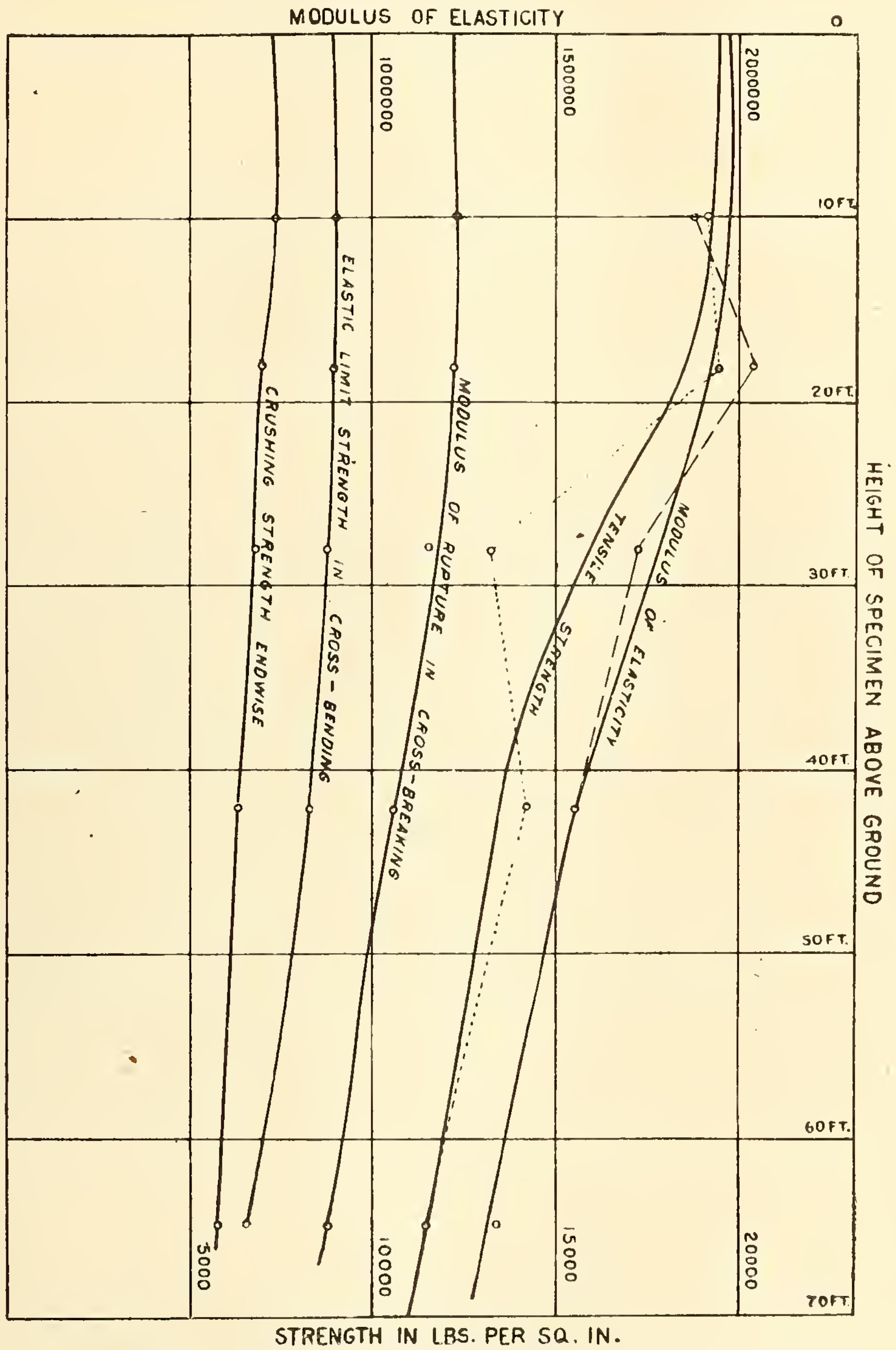


FIG. 16.—Variation of strength with distance from the ground. Long-leaf pine (*Pinus palustris*).

VARIATION IN STRENGTH ACROSS THE SECTION OF THE LOG.

In Fig. 15 are shown the plotted mean results of tests on different portions of the cross-section of a bottom log. These results are from one log only, but many other similar studies show similar relations, so that for any full-grown tree the butt-log, at least, will show similar variation. The general law is that the outer rings of annual growth are the weakest portions of the log, readily

explained by the fact that here the cell walls are thinner. Passing towards the heart, the strength increases and reaches a maximum in the butt of a mature tree at a distance of about one-third of the radius from the heart. In the immediate vicinity of the heart the strength decreases again. In very old trees this strength may diminish to zero, the heart portion decaying and wasting away entirely. For the upper parts of a tree, the central heart portion is doubtless the strongest part of the log.

The variation of strength is not great, however, as shown in Fig. 15, the range being only about 12 per cent of the average strength, namely from 4 per cent below to 8 per cent above the mean strength of all the sticks in this log.

In crushing across the grain and in shearing there seemed to be no relation of variation of strength and radial situation within the log exhibited.

VARIATION OF STRENGTH AT DIFFERENT HEIGHTS FROM THE GROUND.

In Fig. 16 is shown the diminution in strength at increased distances from the base of the tree under the ordinary kinds of stress. The modulus of elasticity (stiffness) and the tensile strength show greatest loss, each losing about 40 per cent of their strength at a height of 70 feet. The cross-breaking strength is reduced by one-third and the crushing endwise strength by only about one-fifth in this distance. The first 20 or 30 feet of the tree seems to be of about a constant strength.

SHEARING AND CRUSHING STRENGTH PARALLEL AND TRANSVERSE TO THE ANNUAL RINGS.

The shearing tests were made in two planes at right angles to each other on each stick. Whenever these shearing planes came parallel and perpendicular to the annual rings, an opportunity was offered for determining the difference in strength in these two ways. The mean results from seventy-five such cases showed a shearing strength on planes parallel to the annual rings of 579 pounds per square inch, and perpendicular to or across the rings of 616 pounds per square inch, a difference of 6.2 per cent. In a similar way the crushing strength across the grain was found to be (mean of 70 tests) 1,106 pounds per square inch, while parallel to the grain it was 1,257 pounds per square inch at the 3 per cent distortion limit, or a strength 12.8 per cent greater parallel to the annual rings. These percentages are both too small to take any account of in actual prac, tice, and can therefore be ignored in this species of timber.

SHRINKAGE IN SEASONING.*

Plate XI seems to indicate that the specific gravity remains practically constant as the per centage of moisture diminishes from 30 to 15 per cent of the dry weight. This implies that the diminution of volume is practically equal to the diminution of weight, so that the weight of unit volume is about constant. This probably holds true in all timbers for slight variations in the percentage of moisture of seasoned lumber or for changes in moisture between 10 and 20 per cent. Ordinary seasoned lumber, left out of doors, will retain about 15 per cent moisture, computed on the dry weight, while wood used indoors, as in house-finishing, furniture, etc., will retain about 10 per cent.

EFFECT OF BOXING OR BLEEDING FOR TURPENTINE ON STRENGTH OF TIMBER.

In a circular by the Forestry Division (No. 8) a preliminary statement of results of tests on timber bled for turpentine was made, which contained the following language:

> One series of tests was instituted to determine the effect which the practice of gathering resinous matter for the manufacture of turpentine and naval stores from the long leaf pine of the South may have upon the strength of the timber of trees subjected to this practice.
>
> The gathering of resin is done by cutting a recess (box) into the foot of the tree, which is called "boxing" the tree, and then scarring (chipping) the trunk above the box, increasing the size of the scar from year to year. From this scar the semi-liquid resin exudates and drains into the box; this process is continued for four years and then the trees, lessening in yield, are abandoned.

* Special studies on this question are carried on in the physical laboratory by Mr. F. Roth, and will be published as soon as completed.

The current public belief has been that the timber of these "boxed" trees, sometimes called "turpentine timber," is deteriorated by the process. Not only is its durability, in which this species excels, believed to be lessened, but also its strength, and hence its value in the market has been considerably reduced.

Since annually from 500,000 to 750,000 acres of this pine are boxed, involving in this assumed deterioration, at the lowest estimate, 1,000,000,000 feet, B. M., of lumber, a considerable loss in values, counting by millions of dollars, is thereby incurred.* The tests conducted in the test laboratory at St. Louis, in charge of Prof. J. B. Johnson, give countenance to the important conclusion that "turpentine" timber seems to possess greater strength than timber from unboxed trees.

The following condensed table of results was given:

Comparative strength of "boxed" and "unboxed" long-leaf pine.

	Specific gravity.	Per cent of moisture.	Tensile strength.	Compressive strength endwise.	Cross-breaking strength.	Modulus of elasticity.	Elastic resilience.	Compressive strength across grain.	Shearing strength.
"Boxed" timber:		*Per cent.*	*Lbs. per sq. inch.*	*Lbs. per sq. inch.*	*Lbs. per sq. inch.*	*Lbs. per sq. inch.*	*In lbs. per cu. in.*	*Lbs. per sq. inch.*	*Lbs. per sq. inch.*
25 sticks "green"	0.759	30.91	15,448	4,755	8,709	1,566,400	1.73	680	540
25 sticks "dry"	.687	18.91	14,757	6,627	11,330	1,644,360	2.71	1,064	648
Percentage of change	−9.5	−39.0	−4.2	+39.4	+30.1	+4.9	+56.6	+56.5	+20.0
Percentage of change to reduce to 20 per cent moisture	−8.5	−3.5	−3.8	+35.5	+27.0	+4.4	+51.0	+51.0	+18.0
Mean of 115 tests	.760	30.9	15,985	5,118	8,988	1,623,000	1.83	743	539
Corrected for 20 per cent moisture.	.696	20.0	15,485	6,935	11,118	1,694,000	2.76	1,122	636
"Unboxed" timber:									
Mean of 133 tests	.710	20.0	16,429	5,661	9,333	1,800,000	1.92	855	652
Excess of "boxed" over "unboxed" timber	−.014	0.0	−.944	+1,274	+1,785	−106,000	+.84	+267	−16
Excess "boxed" over "unboxed," per cent	−2.0	0.0	−5.7	+22.5	+19.2	−5.9	+43.8	+31.2	−2.4

We give in Table III the average results on all "butt" cuts or bottom logs of all trees tested. The first ten trees were unbled, while the remaining sixteen were bled. Eight of these latter (Nos. 52–59) were taken from an orchard which had been abandoned five years; the rest (Nos. 60–67) were from an orchard still in service.

The percentages given in light-faced type in this table are obtained by dividing each test result by the average results for the same kind of tests given in the first four lines of the averages at bottom. The last five vertical columns of the table are derived from these percentages. The "average quality" percentage for each tree represents the average of eight qualities, or it shows the "relative average quality" of this tree as referred to the average of all in its group. These average percentages are given in column 17. In column 18 are given the percentages of each tree (average quality) as related to that of all of its kind, bled or unbled. In column 19 are given the percentages of each group of trees (average quality) as related to that of all of its kind, bled or unbled. These percentages show the two groups of unbled timber to be of exactly equal general strength, while it indicates that freshly bled timber was 4 per cent stronger than that from the trees which had been abandoned five years.

The relative strength of bled and unbled timber is given in column 20, where the percentage of each kind is given in terms of the average of all, giving both kinds equal weight. These percentages show that the butt cuts, or bottom logs, of bled timber are about 7 per cent stronger than those from natural or unbled trees.

By consulting percentage figures in the third and fourth lines from the bottom, it appears that in all of the eight qualities except two, stiffness and tensile strength, the bled timber is superior. In cross-breaking it is 3.4 per cent stronger; the elastic limit in cross-bending is 7 per cent stronger; in elastic resilience it is 15.6 per cent stronger; in crushing endwise it is 7.2 stronger; in crushing across the grain it is 23 per cent stronger; and in shearing it is 13.8 per cent stronger. The bled timber is, however, 6.2 per cent more flexible and 10.4 per cent weaker in tension.

These results prove conclusively that, to say the least, the extracting of the turpentine from long-leaf yellow-pine trees does not in any material sense injure them, so far as strength qualities are concerned. The bled timber is also slightly heavier in the bottom cuts, by about two pounds per cubic foot, as shown by the average specific gravities.

* Later information would increase the average annually added to the turpentine orchards to nearly 1,000,000 acres.

FIELD REPORT ON TURPENTINE TIMBER.

By Filibert Roth.

To learn what was known to practical men, sawmillers, and dealers with regard to the matter of "bled" and "unbled" yellow longleaf pine, a special journey was undertaken by the writer to the principal pine districts of Alabama, Georgia, and the Carolinas. Through the great courtesy of every person visited, valuable information was collected.

The following condensed summary contains this information in brief form:

(1) Most of the timber in Georgia and the Carolinas is bled. In Alabama only a small part is said to be bled. The same answer pertains probably to Mississippi and Louisiana, and in Texas probably no bleeding is practiced.

(2) There is no attempt made in the mills to keep bled and unbled timber separate, nor in the yard.

(3) To the question whether bled and unbled lumber can be distinguished, the universal answer was negative. Of the few exceptions, three belong to South Carolina, one to Georgia, and four to Alabama. Neither of these, when brought to test or asked to state the distinction, were successful.

(4) Experts in lumber being put to test, were said never to have been successful in distinguishing bled from unbled lumber.

(5) Orders for lumber specifying that it be all unbled are not uncommon, though it is said in Atlanta, Ga., they are less common than some years ago.

(6) Serious troubles, involving considerable loss of money, have arisen out of this matter in Alabama and Georgia. These were never settled by selecting the bled from the unbled lumber, but had to be compromised.

The most instructive case of this kind was related in Alabama. It was a case with the Louisville and Nashville Railroad Company, who accept only unbled lumber. The lumber was to be furnished by a mill which cuts only unbled timber. Circumstances retarded the work at this mill, and another mill was engaged to furnish part of the lumber, without special consent of the railway company. When the latter learned of it, they remonstrated: the miller offered to take back all that could be picked out as bled lumber. The railway engineers failing to distinguish the lumber, the matter had to be dropped.

(7) Regarding the effect of four years' bleeding upon the lumber, the following answers were given:

(*a*) It makes it more "pitchy."

(*b*) It is less "pitchy," except in the butt.

(*c*) It frees the sap of resin, but leaves the heart unaffected.

(*d*) It leaves the tree unaffected, except in the butt.

(*e*) It produces "fat streaks" and large amounts of "light wood."

(8) Regarding the question whether bled lumber works better than unbled, the answer was both ways, yes and no; but it was admitted commonly that petroleum was used in either case to keep the knives clean.

(9) Regarding the question whether bled lumber lasts as well as unbled, three answers were given. The general answer was, no; in Georgia it was, yes, and there it was even maintained that it lasts longer. Everywhere it was contended that at least the butt log lasts longer as timber or piling. For inside work no difference was made,

(10) Does bleeding lessen the value of the timber? The common answer was, "yes"; frequently, however, in all parts, "no"; in Georgia it was contended that bleeding improves the timber.

(11) It was generally stated that the yield per acre for the saw-miller was reduced by the practice of turpentine orcharding, even though he followed the turpentine man at once.

(12) Abandoned orchards are always visited by fires and these fires always reduce the yield of saw timber per acre to a very large, although variable, extent.

According to one of Georgia's foremost lumbermen, an orchard bled four years, and then left two more years because the miller was not ready for it, lost 60 per cent of its mill-sized timber.

(13) It is common for turpentine men to box timber far under mill size. The miller can use only from 20 to 50 per cent of the boxed timber and the bled trees not used by the miller mostly die off.

(14) If fire is kept out the bled trees remain alive, but are said, in North Carolina at least, not to be fit for lumber.

From the foregoing statements it appears that all lumbermen are agreed upon the following important points:

(1) That a large proportion of the yellow or long-leaf pine lumber is from bled trees.

(2) That it is never kept apart or distinguished from the unbled by either millers or dealers.

(3) That no available criteria exist by which to distinguish the two kinds of lumber after manufacture.

It is also plain that the opinions regarding difference in quality or the influence of bleeding on the timber or lumber are too contradictory to be convincing, and also that the harm which follows the practice of bleeding lies not in the injury to lumber, but consists in—

(1) Bleeding of trees too small for the sawmill.

(2) Bleeding of tracts of timber not ready for the miller at the time of abandonment.

Careful examination in the laboratory and in the field did not confirm any of the opinions with regard to the effects of bleeding. Some of the most resinous logs were from orchards in South Carolina; some of the "driest" from unbled forests in Alabama. The ordinary "fat streak" is a small wound made and healed over at a time when the place is still at the periphery or outside of the tree, therefore, it is sometimes made more than a hundred years before the bleeding occurred. The long reaches of "light wood" are met in unbled timber. Weight and color are more dependent on the proportion of spring and summer wood than on the amount of resin (except in lightwood) and can, therefore, not serve as distinctions.

The effect of bleeding on the forests appears at first as loss of foliage or thinning of the crown and some trees are evidently killed in two seasons of bleeding; old abandoned orchards everywhere are the very picture of desolation and ruin. The old long bled trees of North Carolina are runts, and show that with the methods at present pursued by the turpentine orchardists, the extraction of resin may sometimes be carried on for long periods, but not without injury to the health and thrifty growth of the trees.

A CHEMICAL STUDY OF THE RESINOUS CONTENTS AND THEIR DISTRIBUTION IN TREES OF THE LONG-LEAF PINE, BEFORE AND AFTER TAPPING FOR TURPENTINE.

By M. GOMBERG.

Botanists tell us that resins are produced by the disorganization of cell walls and by the breaking down of starch granules of cells. Chemists believe that resins are oxidation products of volatile oils, the change being expressed by formula as follows: $2C_{10}H_{16} + 3O = C_{20}H_{30}O_2 + H_2O$.

Whatever view be correct* one thing is certain, and that is that the formation of either resins or essential oils requires the presence in the tree of those peculiar conditions which we call *vital.* The tree must live, must be active, must assimilate carbon dioxide and imbibe moisture, in order that oil of turpentine and rosin be formed.

The heart of the tree is the dead part of it. It does not manufacture any turpentine. A part of the oleoresin in it had been formed when the heart wood was yet sap wood, and remained there after the change from sap to heart had taken place. It is also probable that the heart of the tree acts as a storehouse in which there is deposited a portion of the oleoresin formed in the leaves and sap.

When a tree is tapped for turpentine there are two possible changes that might be supposed to take place: (1) The tree may be considered as placed in a pathological condition, when it will strive to produce a larger amount of oleoresin in order to supply the amount removed. In a few years the energy of the tree will be exhausted, and the amount freshly supplied will fall far below the amount of oleoresin drawn off by the tapping. The tapping will then have to be discontinued. The oleoresin in the heart wood will in this case remain untouched. (2) The oleoresin previously stored away in the heart might, by some unknown means and ways, also be directed toward the wound.

If the first change takes place then, the tapping will have little effect upon the chemical composition of the heart wood. If, however, the second condition prevails during tapping, then, of course, the heart wood will be seriously affected for some time after tapping, and will contain a much smaller amount of oleoresin than it contained before tapping. Moreover, the tapping may affect not only the amount of oleoresin, but also the quality of the new product and the relative distribution of volatile and nonvolatile products.

For this reason the chemical side of the problem has been approached by parallel analyses of tapped or untapped trees for their relative amounts of turpentine. It was hoped that by a large series of analyses an average might be obtained showing whether tapped and untapped trees differ from each other in that respect.

CHEMICAL COMPOSITION OF TURPENTINE.

Under the name of turpentine is known an oleoresinous juice produced by all the coniferous trees in greater or less amount. It is found in the wood, bark, leaves, and other parts of the trees. It flows freely as a thick juice from the incisions in the bark. It consists of a resin or resins dissolved in an essential oil; the latter is separated from the former usually by distillation with steam.

There are many varieties of turpentine corresponding to the different varieties of *Coniferæ*,

* The one view does not exclude the other.

but only three are commercially important, as they are the source of the three principal oils of turpentine.

(1) The turpentine of *Pinus pinaster* (syn. *P. maritima*) collected in the southern departments of France around Bordeaux. From it is obtained the French turpentine, which yields 25 per cent of volatile oil.

(2) The turpentine from *Pinus palustris*, *P. tæda*, *P. Cubensis*, collected in the Southern sea-bordering States from North Carolina to Texas. From them, principally from the first source, is obtained the English or American oil of turpentine, which yields 17 per cent of volatile oil. Formerly the *P. rigida* was also worked for turpentine in the North Atlantic States, but it is now exhausted.

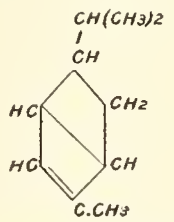
(3) The turpentine from *Pinus larieio* var. *Austriaca*, collected mainly in Austria and Galicia. From it is obtained the German turpentine oil, which yields 32 per cent of volatile oil.

The Russian oil of turpentine is obtained from *Pinus sylvestris* and *Pinus Ledebourii*, by the direct distillation of the resinous wood, without previously collecting the turpentine. It is said to be identical with the German oil of turpentine, but more variable, as it contains products of destructive distillation both of wood and rosin.

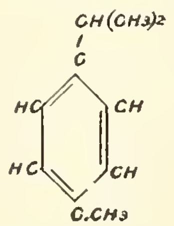
The turpentines from the different sources differ from each other—(1) in their action upon polarized light, (2) in the relative amounts of volatile oil they yield on distillation with steam, and (3) in the nature of the volatile oils they contain.

Colophony.—The resin in the different varieties of turpentine is practically the same. It is known as common rosin or colophony.* It consists chemically of a mixture of several resin acids and their corresponding anhydrides. The chief constituent is abietic anhydride, $C_{44}H_{62}O_4$, abietic acid being $C_{44}H_{64}O_5$. The crystals that are noticed in crude turpentine are the free abietic acid; on melting the thick turpentine, or on distilling the volatile oil, the acid is changed to the anhydride. Colophony is nonvolatile, tasteless, brittle, has a smooth shining fracture, sp. gr. about 1.08. It softens at 80° C, and in boiling water melts completely at 135° C.

The volatile oil.—The second principal constituent of turpentines are the volatile oils. The chief ingredient of the three turpentine oils is a hydrocarbon of the same composition, $C_{10}H_{16}$; nevertheless the three oils have distinct hydrocarbons differing from each other in physical if not in chemical properties. The empirical formula of the hydrocarbon is $C_{10}H_{16}$, and according to the latest researches of Wallach† it has the following structural formula:



thus being a dihydro-para-cymene, paracymene being $C_{10}H_{14}$,



The position of this particular terpene, *pinene*, will be best seen from the general classification of terpenes taken from Wallach.‡

I.—*Hemiterpenes*, or *Pentenes* of the formula C_5H_8.

II.—*Terpenes* or *Dipentenes*, of the formula $C_{10}H_{16}$.

(1) *Pinene*, obtained from many varieties of turpentine.

(2) *Camphene*, obtained artificially from camphor.

* Colophon, a city of Ionia, whence rosin was obtained by the Greeks.

† Ann. Chem. (Liebig), 239, 49; Ber. d. Chem. Ges., 24, 1545.

‡ Ann. Chem. (Leibig), 227, 300; Ber. d (Chem. Ges.), 24, 1527.

(3) *Fenchene*, obtained artificially from fenchone, a constituent of many fennel oils.

(4) *Limonene* occurs in orange-peel oil, in oils of lemon, bergamot, cummin, etc.

(5) *Dipentene*, obtained artificially from pinene. Occurs in Russian and Swedish turpentine.

(6) *Sylvestrene*, occurs in Russian and Swedish turpentine.

(7) *Phelandrene*, occurs in the oils of bitter fennel and water fennel, elemi, eucalyptus.

(8) *Terpinene*, occurs in oil of cardamom.

(9) *Terpinolene*, only slightly known.

III.—*Polyterpenes*, of the formula $(C_5H_8)_n$, as cedrenes $C_{15}H_{24}$, caoutchouc $(C_5H_8)_n$, etc.

The hydrocarbon of the American and French oils of turpentine is pinene. It is dextro-rotatory when obtained from the American turpentine oil, and is known as *austro-terebinthene* or *australene;* lævo-rotatory when obtained from the French turpentine oil, and is known as *terebinthene*. Otherwise the two hydrocarbons agree entirely in specific gravity, boiling point, and behavior towards chemical reagents.

The hydrocarbon of the Russian oil of turpentine is *sylvestrene*. It is dextro-rotatory, and has a higher boiling point than pinene. The latter boils at 155° to 156° C., the former at 175° to 178° C.

But even the turpentine oils of high grade as found on the market do not consist of pure pinene; especially is this true of ordinary oil of turpentine, which is obtained from the cruder turpentine by a single distillation with steam. Different samples vary from one another considerably in their specific rotary power as well as in their boiling point.

American oil of turpentine has a density of 0.864° to 0.870°. According to Allen* it begins to boil at a temperature between 156° and 160° C., and fully passes over below 170° C. "A good sample of rectified American oil will give 90–93 per cent of distillate below 165°, the greater part of which will pass over between 158° and 160°"†, while in the experience of J. H. Long,‡ "In the examination of a large number of pure commercial samples of turpentine oil it was observed that the boiling point was uniformly at 155° to 156°, and that 85 per cent of the samples distilled between 155° and 163°. The distillation is practically complete below 185° C."

Then, again, as found by Long, the vapor densities of many samples of oil are too high to allow the formula $C_{10}H_{16}$ for the entire oil. Fractions of different boiling points show different degrees of specific rotation. All this would indicate that ordinary turpentine oil contains hydrocarbons heavier than pure pinene, $C_{10}H_{16}$. They are probably either isomeric with pinene, but of a higher boiling point, or may belong to the polyterpenes.

Still less do we know of the source of these hydrocarbons. Whether they are produced by the tree simultaneously with pinene, and are, therefore, to be found in the oleoresin, or whether they are all or in part produced by external agencies after the turpentine has been dipped, can not be answered. Probably the formation of these other hydrocarbons takes place in both ways spontaneously in the tree and by some influences outside the tree.

Indeed, all terpenes have this property in common that they easily undergo change, from optically active to inactive, from hemiterpenes to terpenes and polyterpenes. The change can be brought about either by heat alone, or by heating the terpenes with salts or acids. So, when a sample of American turpentine oil of +18.6° was heated to 200° C. for two hours, it showed an opposite rotation of −9.9°.§ Pinene heated to 250° to 300° is converted into dipentene $C_{10}H_{16}$, boiling at 175°, and a hydrocarbon $C_{20}H_{32}$, boiling at 260° C.

These illustrations will suffice to show that the transformation of pinene into isomeric and heavier hydrocarbons may occur, at least partially, after the turpentine has been removed from the tree.

The crude turpentine from *Pinus palustris*, or long-leaf pine, is thus made up of—

(1) Rosin, 75 to 90 per cent; mostly abietic anhydride.

(2) Australene, 25 to 10 per cent; boils at 155 to 156° C.

(3) Some other terpenes of $C_{10}H_{16}$; small portions; kind not known.

(4) Some polyterpenes of $(C_5H_8)_n$; small portions; kind not known.

(5) Cymene (?) $C_{10}H_{14}$; small portions, if any; boils at 175° to 176° C.

(6) Traces of formic and acetic acids; produced probably by atmospheric oxidation during collection of turpentine.

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*Allen, *Com. Org. Anal.*, 2, 437.

†Allen, *Com. Org. Anal.*, 2, 441.

‡*Jour. Anal. and Appl. Chem.*, 6, 5

§ Muspratt's Chemie, 4th ed., 1, 153

ANALYTICAL WORK.

As both the rosin and the volatile oil are easily soluble in chloroform, ether, carbon disulphide, etc., their separation from wood by any of the above solvents would appear to be an easy matter. But an exact quantitative determination of the volatile oil presents considerable difficulties, and for these reasons: (1) Wood can not be dried free from moisture without driving off some of the volatile hydrocarbons; (2) the ether extract can not be freed entirely from ether without some loss of the volatile oil.

If a weighed quantity of wood shavings is exhausted with ether, the residue dried at 100° C. and weighed, the total loss thus found will represent:

The moisture $= H$.
The rosin $= R$.
The volatile hydrocarbons $= T$.

It is sufficient to determine two of these factors; the third could then be determined by difference. But as has been mentioned before, the ether extract can not be obtained in any degree of purity without loss of turpentine. The evaporation of ether in a stream of dry air, as proposed by Dragendorf, for the estimation of essential oils in general, does not give satisfactory results with turpentine oil, as Dragendorf himself observed.

A weighed quantity of a mixture of rosin and oil, made up in about the same proportion as they exist in crude turpentine, was dissolved in a suitable amount of ether. The latter was then evaporated in a current of dry air till the odor of ether was hardly noticeable. The mixture was found to have gained considerably in weight by retaining ether in the thick sirupy oleorosin. It was only by heating at 100° C. for some time that all of the solvent could be driven off, and then the mixture was found to have lost in weight. Repeated trials proved that this method could not be used safely.

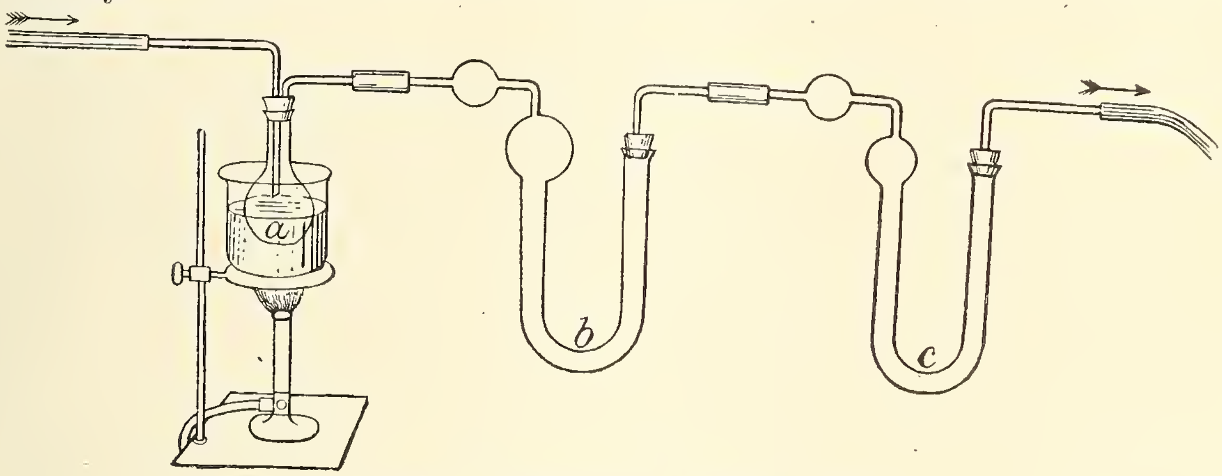


FIG. 17.—Method of chemical analysis of turpentine.

An attempt was then made to determine the quantities H and R, and thus find T by difference. A weighed quantity of wood shavings was placed in a small flask, a. The latter was connected on one side with a tray of drying bottles, on the other with two $CaCl_2$ tubes, b and c, similar in size and form. The flask is immersed in boiling water and a current of dry air is passed through the whole apparatus for one and one-half hours. The flask is then cooled and air is passed for one and one-half hours longer. (Fig. 17.)

It was thought that while b would retain all the moisture and a portion of the volatile compounds, c would retain about the same amount of the volatile products only. Gain in weight of c subtracted from that of b would then give the moisture H. The sample of wood shavings is then exhausted with ether, the latter evaporated, and the residue heated at about 140° to 150° to constant weight; this gives the rosin R. If L be the total loss by extraction with ether, we have

$$L-(H+R)=T.$$

But it was soon found by experiments upon pure turpentine oil that the two $CaCl_2$ tubes did not retain an equal amount of volatile oil. The quantity retained depended upon many circumstances, the chief one being the amount of moisture already present in the $CaCl_2$ tubes.

Even had the tubes retained equal quantities of turpentine oil, this method would still have the objection that one of the constituents was to be determined by difference—an objection especially serious when the ingredient to be so determined is small in comparison with the materials to be weighed.

The writer has therefore attempted to make use of a somewhat different principle. A few trials were sufficient to show that the method promised to give satisfactory results. The basis of the method is the same which serves for the production of Russian turpentine oil on a large scale, namely, the distillation of the volatile products from the wood itself, without previously obtaining the turpentine. But instead of condensing the volatile products, their vapors are passed over heated copper oxide whereby they are burned to water and carbon dioxide. Many trials were made with this method upon pure materials and on samples of resinous wood; as the results were found to be entirely concordant and satisfactory, the method was adopted, and by it were obtained the results presented in this report.

DESCRIPTION OF THE METHOD EMPLOYED.

A weighed amount of wood shavings is placed in a straight $CaCl_2$ tube *a*. The tube is connected on one side by means of a capillary tube with a drier A, which serves for freeing the air from moisture and CO_2. The other end of the tube is connected with an ordinary combustion tube *b* containing granulated CuO. The tube is drawn out at one end as is shown in the figure, and the narrow portion is loosely filled with asbestos wool. The connection is made glass to glass, so that

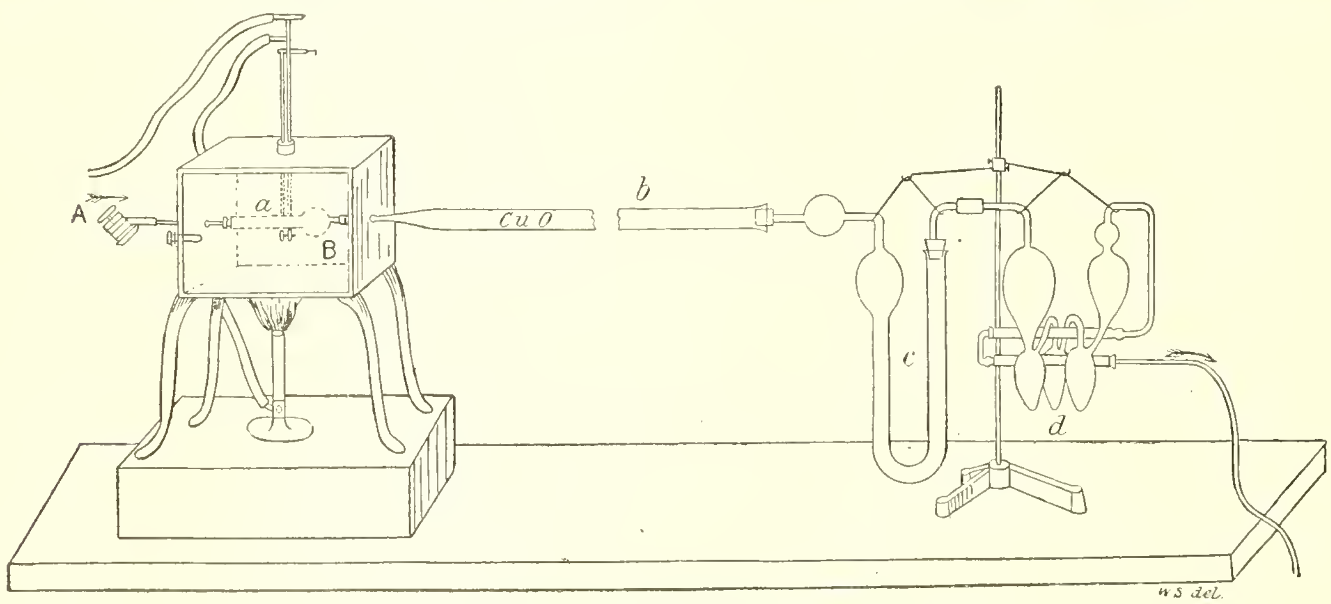


FIG. 18.—Method of distillation of turpentine.

the vapors of distillation do not come in contact with any rubber tubing. The forward end of the combustion tube is connected with a $CaCl_2$ tube *c*, one-half of which is filled with granulated $CaCl_2$ and the second half with P_2O_5. Then follows a potash bulb *d* provided with two straight tubes, the first one filled with solid KOH, the second with P_2O_5. The last tube is connected with an aspirator.

All the connections having been made air-tight, the connection between the tube *a* and the drier A is shut off by means of a clamp and the aspirator turned on. When the combustion tube has been heated to dull redness the burner under the air-bath B is lit and the temperature raised to 110°–120° C. The moisture contained in the tube escapes quite rapidly, carrying with it some turpentine oil. The capillary tube at the other end of *a* practically checks backward diffusion or any accumulation of condensed vapors. In about 15 minutes all the moisture appears at the forward end of the combustion tube. The clamp is now opened and a stream of air at the rate of somewhat over one liter an hour is passed though the whole apparatus, while the temperature of the air bath is raised to 155° to 160° C., and kept at that point for about 45 minutes. Towards the end of the operation the temperature is raised to 165° to 170° C. for 10 minutes. Then the light under the air-bath is turned off and air aspirated for 20 to 25 minutes longer. As the air-bath is

in close contact with the combustion furnace the whole length of the tube is kept at a temperature above the boiling point of turpentine oil; in this way a complete distillation is insured.

All the moisture is retained by *c*, while the CO_2 is absorbed in the potash bulb *d*. The gain in weight of *c* represents the moisture originally present in the sample of wood + the water produced in the combustion of the hydrocarbons. The gain in weight of *d* represents the amount of CO_2 derived from the combustion of the volatile products.

The tube *a* is now transferred to an ordinary Loxhlet's extraction apparatus and exhausted with ether. The latter is distilled off, the residue dried for about 2 hours at 100° C. and weighed. This represents the amount of rosin in the sample of wood taken.

As has been previously mentioned, the volatile oil of the oleoresin is not pure australene $C_{10}H_{16} = (C_5H_8)_2$: It probably contains some other hydrocarbons, either of the same formula or belonging to the class of polyterpenes $(C_5H_8)_n$. It is clear that whichever they be, their percentage composition is alike in all; they all have $C = 88.23$ per cent, $H = 11.77$ per cent. Therefore, so far as the combustion of the volatile terpenes is concerned, they can all be represented by the equation

$$\underbrace{C_{10}H_{16}}_{136} + 14O_2 = \underbrace{10CO_2}_{440} + \underbrace{8H_2O}_{144}$$

In other words, 440 parts of CO_2 are derived from 136 parts of volatile terpenes.

$$440:136 = 1:X; \quad X = 0.3091$$

i. e., 1 part of CO_2 obtained in the combustion represents 0.309 parts of volatile hydrocarbons.

For every 440 parts of CO_2 produced there are 144 parts of H_2O formed.

$$440:144 = 1:X; \quad X = 0.3272.$$

i. e., simultaneously with 1 part of CO_2 there is produced 0.327 parts of H_2O.

Let the weight of the sample taken $= W$
Let the weight of CO_2 obtained $= W'$
Let the weight of H_2O obtained $= W''$

Then—$W' \times 0.309 = T$, the amount of volatile hydrocarbons.
$W' \times 0.327 = H'$, the amount of H_2O corresponding to the volatile hydrocarbons.
$W'' \times - H' = H$, the amount of moisture in the wood.
$\frac{T}{W} =$ per cent of T; $\frac{H}{W} =$ per cent of moisture.

Thus the moisture, the volatile hydrocarbons, and rosin are obtained directly from the same sample. Where many estimations are to be made it is of course unnecessary to cool down the combustion tube between successive combustions.

The temperature of distillation.—Some experiments were made to determine at what temperature it is safe to conduct the distillation. Although pure turpentine boils at 156–160° C., yet in open air it can be volatilized at a much lower temperature, even on the water-bath, without any difficulty. Especially is this the case when the vapors are removed as soon as formed by a stream of air, but it must be remembered that the volatilization of the essential oil directly from the wood might be considerably hindered by the large amount of rosin.

A sample of wood distilled by the method outlined above gave the following results at different temperatures:

	120°	140°	156°–60°		170°
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
$T=$	1.09	1.18	1.30	1.26	1.32
$H_2O=$	11.17	11.33	11.23	....	....

Another sample gave:

	160°	180°
	Per cent.	*Per cent.*
$T=$	4.00	3.98
$H_2O=$	8.79	

The results would indicate that the distillation is practically complete at 160° and that the wood itself does not contribute any CO_2 by partial decomposition at that high temperature, for, should the latter be the case, higher results might be expected at 180° than at 160° and then the sapwood would give much higher numbers for turpentine oil than those actually obtained.

Even if this method does not give the absolute amounts of volatile hydrocarbons, yet it certainly gives results very near the truth, and, what is more important, under the same conditions it gives constant results. Therefore, by employing strictly parallel conditions in the analysis of the different samples, results are obtained which can be safely used as indices of comparison of the relative amounts of volatile hydrocarbons in the samples under analysis.

Material for analysis and method of designation.

Materials.—Trees No. 52 and 53, abandoned 5 years.
Trees No. 60 and 61, abandoned 1 year.
Trees No. 1 and 2, not tapped.
Trees 54–57, abandoned 5 years.
Trees 58–59, abandoned 5 years
Trees 63–65, abandoned 1 year.
Trees 66–69, abandoned 1 year.
Trees 17–19, not tapped.
Generally disk II is 23 feet from ground.
disk III is 33 feet from ground.
disk IV is 43 feet from ground.

Method of designation.—It was thought best to make a somewhat detailed analysis of a few bled and unbled trees in order to gain an insight into the quantitative distribution of turpentine in the trees. Each disk was divided into pieces of about thirty rings each, the heart and sapwood, being kept separate. The number of the disk is designated by a Roman figure, the kind of wood by either *s* for sapwood or *h* for heartwood. The Arabic figure which precedes the *h* or *s* designates the number of the piece counting for the sapwood from the bark, for the heartwood from the line of division between sap and heart.

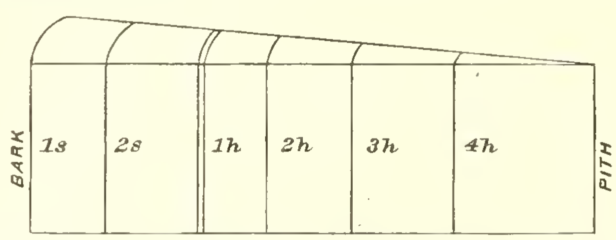


FIG. 19.—Distribution of turpentine in trees. (A piece marked 52, III. 2*h* means tree No. 52, disk III, the second piece of the heart.)

Preparation of material.—The first six tables give the results of what might be called "detail" analysis, where each piece of about thirty rings has been analyzed separately. The material for analysis was prepared in the following way: A radial section of the disk, about 1 to 2 inches thick, is selected. A piece of 1 inch is cut off transversely and the strip is then divided into pieces of about thirty rings each. From the freshly cut transverse surface about 15 grams of thin shavings are planed off and placed in a stoppered bottle. The exact amount used for analysis, usually from 3 to 5 grams, is found by weighing the bottle before and after taking out the portion for analysis.

The second set of tables, VII to XII, inclusive, give the results of "average" analysis. The material for these analyses was obtained by mixing equal quantities of shavings from the corresponding portions of several trees and taking for analysis an average sample of the mixture. The sap wood furnished one analysis, and the heart wood was either analyzed as a whole or divided into two portions, 1*h* and 2*h*, if of considerable thickness.

Notes on Tables I to XII.

Each table contains a column "calculated for wood free from moisture," giving the per cent of volatile hydrocarbons and rosin obtained by calculation from results actually found. Objections might be raised to this mode of interpreting the results. It might be said that the moisture in the

wood can not be disregarded because it is as much an essential proximate constituent of wood as the turpentine itself is. But since the analyses were not made soon after the trees had been felled, the moisture found in the samples does not represent the original moisture, nor does it represent equal portions of it in all samples. The numbers given in the column "water" are of course suggestive as to the comparative degree of retention of moisture by the different samples, since the latter were all exposed to about the same influences. But it seemed best to compare the amounts of volatile hydrocarbons and rosin on wood free from that variable constituent; the more so as some time elapsed between the analysis of the first and last samples.

The last column in each table contains the ratio between the volatile hydrocarbons and rosin. This ratio is multiplied by 100 and means that for every 100 parts of rosin as many parts of the volatile hydrocarbons are found as is indicated in the column. This ratio $\left(\frac{T}{R}\right)$ is of little value in cases when the amount of turpentine is small, because a very small increase of the first constituent—an increase within experimental error—will change the quotient considerably. An increase of 0.07 per cent of volatile hydrocarbons in 60, IV, 1*s* will bring up $\frac{T}{R}$ from 7.2 to 10. A decrease of 0.07 per cent in 52, IV, 2*s* will change $\frac{T}{R}$ from 25.20 to about 19. These numbers are therefore of very little significance when applied to the sapwood of all samples, to entire tree 52, and to some parts of trees 60 and 1, all of which show only small portions of turpentine.

DISCUSSION OF RESULTS OBTAINED.

Relation of rosin and volatile hydrocarbon to moisture.—The amount of moisture retained by different samples does not seem to have any direct relation to the amount of oleoresin in these samples. Yet in the same tree, or rather in the different parts of the same disk, there seems to exist something like a relation of the two. This is especially noticeable in tree No. 53. The moisture retained seems to vary inversely with the amount of oleoresin in the sample. Compare for example in 53 II, 1*h*, 2*h*, 3*h*; in 53 III, 1*h*, 2*h*, 3*h*, 4*h*; in 53 IV, 2*h*, 3*h*, 4*h*. The piece richest in oleoresin is generally the poorest in moisture. But this is by no means a universal rule. Some trees show about the same per cent of moisture in parts widely differing from each other in the amounts of turpentine, and in many instances a smaller amount of turpentine is associated with a smaller per cent of moisture.

Sapwood and heartwood.—All the analyses, detail and average, show conclusively that the sapwood is comparatively very poor in turpentine; it is immaterial whether it comes from a rich tree or a poor one, from a tapped tree or an untapped one. The turpentine in sapwood reaches 3 to 4 per cent in very rich trees, as in Nos. 53, 61, and 2; in the remaining trees it is 2 to 3 per cent. Consequently the results obtained for sapwood are not taken into account in the following paragraphs. When differences between trees are spoken of, it applies entirely to heart-wood.

The different parts of the same disk show a constant relation in nearly all instances. In most cases 1h is the richest, and the heartwood grows poorer as we approach the pith of the tree. In a few cases, as in 1 III and in 1 IV, 1*h* and 2*h* are practically identical, while in some instances, in 2 III, 61 II, 61 III, and 53 II, 1*h* is poorer than 2*h*. In nearly all cases the decline is marked in 3*h*, and 4*h* is usually found to be the poorest part of the disk. This relationship can be represented in a general way by the following curve.

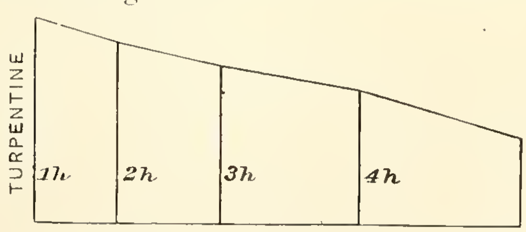


FIG. 20.—Relationship of different parts of same disk.

Relation of volatile hydrocarbons to rosin.—As the turpentine in the tree is a solution of resin in an essential oil, it will follow that the richer a tree is in turpentine the richer it will be in the constituents that go to make up this mixture. One would also expect that the ratio between the volatile hydrocarbons and rosin would be tolerably constant in the different parts of the same tree. But the results of analysis do not indicate it. They show that this ratio increases with the

amount of rosin. A part of heartwood having twice as much rosin as another part will contain more than twice as much volatile products as the second part. This is true in a general sense of parts of the same disk, of parts of different disks in the same tree, and parts from different trees; there is no distinction in that respect between bled and unbled trees. This relationship can be formulated in the following way: The crude turpentine from heartwood rich in oleoresin, will yield a comparatively larger amount of turpentine oil than the turpentine from heartwood poor in oleoresin.

It has been shown that the heartwood grows poorer from 1h towards the pith of the tree. It will therefore follow from what has been said in the preceding paragraph that $\frac{T}{R}$ will also grow smaller from 1*h* to the pith. The yield of volatile oil from a constant quantity of turpentine can be expressed in a general way by a graphic illustration similar to that which expresses the yield of total oleoresin from different parts of the disk.

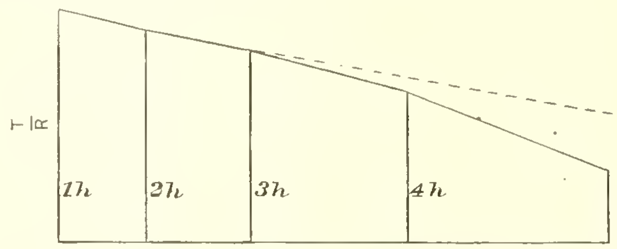


FIG. 21.—Yield of volatile oil from constant quantity of turpentine.

It is difficult to explain satisfactorily this decrease of $\frac{T}{R}$. The two parts of the radial sections that have been the longest exposed to air are 1*s* and the last *h*. the question naturally arises—May not the decrease of $\frac{T}{R}$ be due to a greater evaporation of volatile hydrocarbons from these two ends? But this can hardly be so. 53, II, 4*h* was analyzed at intervals of two months and furnished the following data:

I. Sept. 28.	II. Nov. 27.
H_2O = 11.23	7.24
T = 1.30	1.34
R = 7.96	8.12

Calculated for wood free from moisture:

I.	II.
T = 1.30	1.30
R = 8.96	8.75

Sufficient experimental data are lacking to prove conclusively that the volatile hydrocarbons do not evaporate to any extent from the heartwood, except from freshly cut surfaces of it.

Relation between different disks of the same tree.—There is no constant relation between the different disks of the same tree so far as the amount of oleoresin is concerned. Although the disks do vary from each other, the variation can not be connected with gravitation by virtue of which the lower disks would contain a larger amount of turpentine than the upper ones; for different trees vary from each other considerably in that respect, the variation being apparent in both bled and unbled trees. If *a*, *b*, *c* stand for the amounts of oleoresin in disks denoted by Roman numbers, the relative magnitudes being represented by the letters in the alphabetic order, then the results of analysis can be condensed in the following table for the trees denoted in Arabic numbers:

	53	60	61	1	2
IV	*a*	*b*	......	*a*	*c*
III	*b*	*c*	*a*	*c*	*b*
II	*c*	*a*	*b*	*b*	*a*

It is evident that no constant relation, as to amounts of oleoresin, exists between the disks of the same tree.

Comparison of tree 52 with 53.—These two trees were both supposed to have been sound, healthy trees at the time of felling, and yet they differ from each other as much as two trees could differ. The heartwood of one is very rich in turpentine, that of the other contains comparatively very small quantities, only a trace. How to explain this difference? Previous to felling they had both been tapped for four consecutive years, consequently both must have contained considerable amounts of turpentine. Since the last tapping they stood for five years side by side, both exposed to the same influences. This great difference can not be traced directly to tapping, for the latter, it may be assumed, would have affected both trees equally. The cause of the difference between 53 and 52 ought to be looked for, rather, in the condition of the two trees before tapping. In connection with this it would be interesting to know how much turpentine had each tree yielded when tapped.

Comparison of tree 60 with 61.—There is a decided difference between the two trees. The highest numbers in 60 are 0.84 per cent for volatile hydrocarbons and 5.35 for rosin, while in 61 0.75 and 5.67 are the lowest numbers for the corresponding constituents, the highest being 3.49 and 16.29, respectively. Here again we have two trees of about the same age, under apparently the same conditions of growth, tapped at the same time and abandoned for the same length of time before felling, and yet differing very widely from each other. It is difficult to conceive why tapping should have affected the heartwood of these two trees in such a strikingly different manner. If the assumption is made that the tapping had drained both trees equally, what explanation can be given for the fact that within only one year of abandonment one tree is very rich in turpentine, while the other has less than one-fourth as much?

Comparison of trees 52 and 53 with 60 and 61.—Compare 53 and 61. Here we have two trees both very rich in turpentine, but while 53 had five years of rest after tapping, 61 had only one year. Had the tapping forced the trees to pour out their oleoresin previously stored up in the heart, we should expect to find in the *time of rest* the prime factor for a tree in resuming its natural condition. But, on the contrary, results of analysis show that time of abandonment before felling is of little importance. While we can have a tree very rich in turpentine within five years after tapping, we can also have trees rich and poor even within one year, and trees almost totally deprived of turpentine in the heartwood within five years after tapping.

Comparison of 1 with 2.—These two trees had never been tapped, and yet neither is rich in turpentine. No. 2 contains about twice as much turpentine as No. 1, the difference becoming smaller as we go up the tree. The highest numbers for 2 are 1.93 and 14.19 for T and R, respectively, the lowest 0.86 and 5.89, with an average of about 1 and 7. We can say that there is as much difference between untapped trees as there is between trees that have been tapped.

Average analyses.—The average analyses cover 16 trees; 13 trees furnish 4 sets of analyses of tapped trees, and 3 trees furnish 1 set of untapped. The results obtained are summarized in the following table:

	II.			III.			Remarks.
	T.	R.	$\frac{T}{R}\times 100$.	T.	R.	$\frac{T}{R}\times 100$.	
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*		
54–57	0.93	5.88	15.58	0.58	3.98	14.04	Abandoned 5 years.
57–59	0.80	4.06	19.63	0.82	4.29	19.10	Do.
63–65	0.91	5.32	17.18	....	....	....	Abandoned 1 year.
66–69	0.89	4.95	18.00	....	....	....	Do.
17–19	0.64	2.98	21.37	0.71	3.21	21.76	Not tapped.

These results show a pretty constant average number for turpentine in tapped trees. The heartwood of untapped trees is poorer in both volatile oil and rosin than that of tapped trees. And here again it is worthy of notice, that time of abandonment is of little importance to tapped trees. The trees that had been abandoned for one year are fully as rich as those that had five years to recover from tapping.

Comparison of tapped with untapped trees.—If now the heartwood of tapped trees be com-

pared with that of untapped, one is at a loss as to what conclusions should be drawn from so few analytical data. It is remarkable that the two richest trees and the poorest tree are among those that had been tapped. Of the remaining 19 trees there is no difference between the 14 tapped and 5 untapped. Whatever differences are found among bled trees are equally found among those that have not been tapped.

Indeed, from the study of the results of analysis the writer is of the opinion that the difference in untapped trees is due to the same cause as the difference in trees that have been tapped. As stated on page 43, the cause of the difference among tapped trees can not be traced directly to tapping; it ought to be looked for, rather, in the condition of the trees previous to tapping.

The difference between trees 52 and 53 can be explained on the following hypothesis: 53 had been a rich tree from early growth, and had a large amount of turpentine stored up in the heartwood; 52 for some reason or other had very little stored away. When the two trees were subjected to tapping they gave up whatever turpentine they had in the *sapwood* and whatever they could produce from season to season, till at the end of four years the production became too small in amount and too poor in quality. The trees were then abandoned. But tree No. 53 had its oleoresin in the heartwood untouched, while No. 52 had hardly any before tapping, and for the same unknown cause did not store away any in the heartwood since the tree had been abandoned.

The explanation offered in the preceding paragraph gains still more probability when trees 60 and 61 are compared with each other and also with 52 and 53. The difference between 1 and 2, the results of average analyses, all these are very suggestive of the theory that the sap and not the heart of the tree supplies the turpentine when the tree is tapped. The fact that the heartwood of trees felled one year after tapping is fully as rich or as poor as that of trees felled five years after tapping seems to the writer of especial significance, for it shows that the richness of the heartwood in a tapped tree is independent of time of rest before felling.

It is a well-known fact that when a pine tree is cut transversely, liquid turpentine immediately appears on the fresh surface of the sapwood, while the heartwood remains perfectly clear. It would seem as if the turpentine in the sap is far less viscid than that in the heart of a tree. It is probable that the turpentine in the sap is richer in volatile hydrocarbons than that in the heart. [A difference of cell structure and manner of existence of oleoresins may also account for this difference in part.—B. E. F.]

It is generally stated that crude turpentine as obtained on a large scale yields from 10 to 25 per cent of volatile oil. This gives $\frac{T}{R} = 11.11$ to 30, with an average of over 20. This average is somewhat higher than that for the $\frac{T}{R}$ as found for the turpentine from heartwood of the 21 trees analyzed. Although experimental data are wanting to show conclusively that the difference in the consistency of the oleoresin from sapwood and heartwood is due to a difference in the relative amount of volatile oil, yet it is quite probable that this should be the cause. The oleoresin in the heartwood of trees has been produced for the most part when the heartwood was yet sapwood. Therefore that part of turpentine which is found in the heartwood is the oldest in age, and consequently has been exposed the longest to oxidizing influences of air, which gradually replace the water when the sapwood changes to heartwood. It is the same kind of oxidation and of thickening which takes place when crude turpentine is exposed to the air and sun, or when a fresh cut is made in the bark of a tree. It is probably for the same reason that $\frac{T}{R}$ becomes smaller as we approach the pith of the tree, because the parts nearest the pith are the oldest.

It is difficult to conceive how the thick oleoresin of the heartwood could be made to flow towards the incision when a tree is tapped. It is also difficult to explain by what means the tree could change this thick turpentine into a less viscid solution in order that it may flow toward the wound.

One would judge, *a priori*, from the great difference in the consistency of the turpentine in the heart and sap that only the liquid turpentine will flow when a tree is tapped. Tapping will then have little effect, if any, upon the oleoresin stored up in the heartwood of the tree. A tree whose heartwood is rich in turpentine will remain so after tapping.

The writer is not willing to generalize too hastily from so few results and consider them as a solution of the problem. A large number of analyses devoid of the possibility of chance selection of samples is necessary before a positive or a negative answer can be given to the question, Does the tapping of trees for turpentine affect the subsequent chemical composition of the heartwood?

But, however few in number the results are, they admit of the following conclusions:

(1) Trees that have been tapped can still contain very much turpentine in the heartwood.

(2) Trees that have been abandoned for only one year before felling can contain fully as much turpentine in the heartwood as trees that have been abandoned for five years.

(3) Trees that have not been tapped at all do not necessarily contain more turpentine in the heartwood than trees that have been tapped.

The accompanying diagram (page 46) serves to show what proportion of each disk was involved in each of the detail analyses, and the results in each case. The right-hand vertical line represents the pith of the tree, the horizontal lines represent the radial extension of each disk as numbered by roman number, the position of the disk in the tree being maintained as in natue, IV being the top, II the lower, and III the intervening disk. The subdivisions of radii represent the actual divisions of the disk to scale of one-half natural size, the portions to the left of the heavy subdivision line representing sapwood *s* 1 and *s* 2; the portions to the right heartwood h_1, h_2, divided according to the method as indicated on page 41. The four columns of figures over each disk-piece represent results pertaining to that piece; they stand in order from the top for (1) number of rings, (2) volatile hydrocarbons, (3) rosin, (4) ratio $\frac{T}{R}$; (2) and (3) as calculated on wood free from moisture. For instance, for tree No. 53, disk IV, *s* 2, we find—

40 = Number of rings.
0.40 = Per cent of volatile hydrocarbons.
3.81 = Per cent of rosin.
$10.37 = \frac{T}{R}$.

Tree	Disk							
Tree No. 53.	IV.	40. 0.40 3.81 10.37	30. 0.46 3.96 11.60	34. 4.56 24.01 19.02	33. 4.49 22.23 20.12	31. 3.86 17.74 21.77	35. 2.66 15.19 17.53	
	III.	40. 0.39 2.96 13.01	37. 0.42 3.02 13.82	35. 3.87 21.77 17.85	38. 3.81 20.09 18.94	30. 2.10 11.97 17.53	18. 1.25 9.71 13.10	
	II.	37. 0.18 0.97 18.39	40. 0.19 0.96 19.77	33. 2.56 12.02 21.23	32.00 4.39 24.70 22.43	32. 2.22 12.30 18.29	28. 1.46 8.96 16.33	
Tree No. 52.	IV.	40. 0.26 1.40 18.78	35. 0.34 1.34 25.20	32. 0.15 1.65 9.33	34. 0.22 1.97 11.11	30. 0.23 1.72 13.38	30. 0.26 1.92 13.64	
	III.	30. 0.25 1.99 12.71	40. 0.25 1.87 13.67	30. 0.15 1.77 8.64	30. 0.20 1.87 10.51	32. 0.14 1.86 7.65	27. 0.18 1.60 9.65	11. 0.18 1.53 9.26
	II.	40. 0.30 2.19 13.64	40. 0.31 2.01 15.48	36. 0.30 2.17 14.14	32. 0.26 1.83 14.38	35. 0.17 1.98 8.83	24. 0.17 1.51 11.60	
Tree No. 61.	III.	30. 0.22 3.01 7.35	36. 0.28 2.75 10.20	40. 3.07 13.55 22.65	33. 3.49 16.29 21.42	35. 3.14 14.18 21.42	30. 1.08 8.04 13.39	
	II.	35. 0.20 3.01 6.50	35. 0.26 3.11 8.36	36. 1.57 7.88 19.85	33. 2.69 13.57 19.86	30. 2.92 11.34 25.81	35. 0.75 5.67 13.28	
Tree No. 60.	IV.	30. 0.16 2.32 7.02	27. 0.24 2.66 9.09	28. 0.84 5.35 15.59	36. 0.41 3.13 12.85	40.		
	III.	30. 0.28 2.65 10.33	34. 0.35 2.88 12.16	30. 0.58 3.60 15.27	36. 0.40 2.99 13.23	36. 0.42 2.42 17.04	20. 0.50 3.39 14.70	
	II.	30. 0.29 2.26 12.74	35. 0.33 2.63 12.56	37. 0.71 5.03 14.07	33. 0.51 2.71 18.62	35. 0.73 5.19 14.02	27. 0.47 3.62 13.00	
Tree No. 1.	IV.	30. 0.22 1.43 15.27	28. 0.25 1.57 15.97	32. 1.07 7.61 14.12	19. 1.06 6.62 16.04			
	III.	30. 0.32 2.25 14.49	33. 0.34 2.25 13.90	30. 0.94 4.90 19.11	25. 0.73 5.12 14.21	13. 0.40 3.57 11.20		
	II.	30. 0.20 1.06 18.55	35. 0.17 1.32 13.72	35. 0.18 6.57 17.97	34. 0.66 3.92 16.67	15. 0.37 2.23 16.50		
Tree No. 2.	IV.	30. 0.31 2.52 12.12	36. 0.34 2.71 12.36	30. 1.13 8.10 13.98	30. 0.87 6.41 13.53			
	III.	30. 0.18 1.95 8.94	36. 0.24 2.24 10.06	33. 1.37 9.14 14.77	28. 0.92 5.89 15.61	17. 0.86 7.40 11.64		
	II.	30. 0.20 4.29 4.56	26. 0.31 3.05 10.00	34. 1.55 10.10 15.35	30. 1.93 14.19 14.4	30. 1.39 8.78 15.75	11. 1.16 8.94 12.99	

FIG. 22.—Diagram of detail analyses, representing radial dimensions of test pieces in each disk. Scale, one-half natural size.

TABLE I.—*Tree No. 53.*

No. of disk.	Part of disk.	Number of rings.	Width.	Water.	Volatile hydrocarbon.	Rosin.	Calculated on wood free from moisture.		Vol.hydroc. / Rosin. × 100
							Volatile hydrocarbons.	Rosin.	
			Cm.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
II	1*s*	37	3.3	10.51	0.16	0.87	0.18	0.97	18.39
	2*s*	40	4.0	10.05	0.17	0.86	0.19	0.96	19.77
	1*h*	33	3.0	9.11	2.32	10.93	2.56	12.02	21.23
	2*h*	32	2.9	8.79	4.00	17.83	4.39	24.70	22.43
	3*h*	32	5.0	8.47	2.03	11.26	2.22	12.30	18.29
	4*h*	28	10.0	*11.23	1.30	7.96	1.46	8.96	16.33
III	1*s*	40	2.7	9.08	0.35	2.69	0.39	2.96	13.01
	2*s*	37	2.6	8.90	0.38	2.75	0.42	3.02	13.82
	1*h*	35	3.5	7.89	3.57	20.05	3.87	21.77	17.85
	2*h*	38	4.1	8.04	3.50	18.48	3.81	20.09	18.94
	3*h*	30	5.5	8.55	1.92	10.95	2.10	11.97	17.53
	4*h*	18	7.0	8.79	1.14	8.86	1.25	9.71	13.10
IV	1*s*	40	4.0	8.96	0.36	3.47	0.40	3.81	10.37
	2*s*	30	3.0	8.67	0.42	3.62	0.46	3.96	11.60
	1*h*	34	3.9	8.04	4.20	22.08	4.56	24.01	19.02
	2*h*	33	3.0	7.93	4.13	20.56	4.49	22.33	20.12
	3*h*	31	5.8	8.65	3.53	16.21	3.86	17.74	21.77
	4*h*	15	5.3	9.55	2.41	13.74	2.66	15.19	17.53

TABLE II.—*Tree No. 52.*

II	1*s*	40	3.1	9.72	0.27	1.98	0.30	2.19	13.64
	2*s*	40	3.9	9.77	0.28	1.81	0.31	2.01	15.47
	1*h*	36	4.6	8.67	0.28	1.98	0.30	2.17	14.14
	2*h*	32	3.0	8.44	0.24	1.68	0.26	1.83	14.38
	3*h*	35	6.8	8.80	0.16	1.81	0.17	1.98	8.83
	4*h*	24	7.4	8.55	0.16	1.38	0.17	1.51	11.60
III	1*s*	30	3.0	9.12	0.23	1.81	0.25	1.99	12.71
	2*s*	40	3.5	9.00	0.23	1.68	0.25	1.87	13.67
	1*h*	30	3.4	8.44	0.14	1.62	0.15	1.77	8.64
	2*h*	30	3.0	8.51	0.18	1.71	0.20	1.89	10.51
	3*h*	32	4.8	8.37	0.13	1.70	0.14	1.86	7.65
	4*h*	27	6.9	9.35	0.14	1.45	0.15	1.60	9.65
	5*h*	11	5.0	9.21	0.13	1.39	0.14	1.53	9.26
IV	1*s*	40	3.5	8.88	0.24	1.28	0.26	1.40	18.78
	2*s*	35	3.3	8.49	0.31	1.23	0.34	1.34	25.20
	1*h*	32	3.0	9.08	0.14	1.50	0.15	1.65	9.33
	2*h*	34	2.8	8.86	0.20	1.80	0.22	1.97	11.11
	3*h*	30	3.6	8.48	0.21	1.57	0.23	1.72	13.38
	4*h*	30	6.8	8.10	0.24	1.76	0.26	1.92	13.64

TABLE III.—*Tree No. 61.*

II	1*s*	35	3.0	7.94	0.18	2.77	0.20	3.01	6.50
	2*s*	35	3.0	7.90	0.24	2.87	0.26	3.11	8.36
	1*h*	36	2.8	7.35	1.45	7.30	1.57	7.88	19.85
	2*h*	33	3.2	7.58	2.49	12.54	2.69	13.57	19.86
	3*h*	30	4.5	7.64	2.70	10.46	2.92	11.34	25.81
	4*h*	35	9.5	7.10	0.70	5.27	0.75	5.67	13.28
III	1*s*	30	3.0	7.65	0.20	2.78	0.22	3.01	7.35
	2*s*	36	2.7	7.43	0.26	2.55	0.28	2.75	10.20
	1*h*	40	3.1	7.14	2.85	12.58	3.07	13.55	22.65
	2*h*	33	3.2	7.46	3.23	15.08	3.49	16.29	21.42
	3*h*	35	6.0	7.41	2.91	13.59	3.14	14.18	21.42
	4*h*	30	8.0	7.09	1.00	7.47	1.08	8.04	13.39

TABLE IV.—*Tree No. 60.*

II	1*s*	30	2.7	9.91	0.26	2.04	0.29	2.26	12.74
	2*s*	35	2.8	9.34	0.30	2.39	0.33	2.63	12.56
	1*h*	37	3.5	8.72	0.65	4.62	0.71	5.03	14.07
	2*h*	33	4.5	9.15	0.46	2.47	0.51	2.71	18.62
	3*h*	35	4.6	8.01	0.67	4.71	0.73	5.19	14.02
	4*h*	27	6.5	8.45	0.43	3.31	0.47	3.62	13.00
III	1*s*	30	3.1	8.74	0.25	2.42	0.28	2.65	10.33
	2*s*	34	2.8	8.60	0.32	2.63	0.35	2.88	12.16
	1*h*	30	3.2	8.68	0.53	3.47	0.58	3.80	15.27
	2*h*	36	4.4	9.02	0.36	2.72	0.40	2.99	13.23
	3*h*	36	4.5	7.73	0.38	2.23	0.42	2.42	17.04
	4*h*	20	6.0	7.73	0.46	3.13	0.50	3.39	14.70
IV	1*s*	30	2.6	7.51	0.15	2.15	0.16	2.32	7.02
	2*s*	27	2.6	7.84	0.22	2.45	0.24	2.66	9.09
	1*h*	28	3.7	7.77	0.77	4.94	0.84	5.35	15.59
	2*h*	36	5.0	8.12	0.37	2.88	0.41	3.13	12.85
	3*h*	40	8.0	7.92	0.26	2.81	0.28	3.05	9.18

*** 53, II, 4*h* has been analyzed some three weeks earlier than the remaining parts of this tree, hence a large per cent of moisture. See page 46.**

TABLE V.—*Tree No. 1.*

No. of disk.	Part of disk.	Number of rings.	Width.	Water.	Volatile hydrocarbon.	Rosin.	Calculated on wood free from moisture. Volatile hydrocarbons.	Calculated on wood free from moisture. Rosin.	$\frac{\text{Vol. hydroc.}}{\text{Rosin.}} \times 100$
			Cm.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
II	1*s*	30	2.0	8.67	0.18	0.97	0.20	1.06	18.55
	2*s*	35	3.6	8.77	0.16	1.21	0.17	1.32	13.72
	1*h*	35	3.6	8.56	1.08	6.01	1.18	6.57	17.97
	2*h*	34	6.5	8.39	0.60	3.60	0.66	3.92	16.67
	3*h*	14	3.0	7.67	0.34	2.06	0.37	2.23	16.50
III	1*s*	30	2.8	7.94	0.30	2.07	0.32	2.25	14.49
	2*s*	33	3.0	7.92	0.31	2.23	0.34	2.42	13.90
	1*h*	30	3.8	8.13	0.86	4.50	0.94	4.90	19.11
	2*h*	25	4.2	7.78	0.67	4.72	0.73	5.12	14.21
	3*h*	13	3.5	7.57	0.37	3.30	0.40	3.57	11.22
IV	1*s*	30	2.2	8.33	0.20	1.31	0.22	1.43	15.27
	2*s*	28	2.8	8.12	0.23	1.44	0.25	1.57	15.97
	1*h*	32	5.0	7.94	0.99	7.01	1.07	7.61	14.12
	2*h*	19	5.2	7.73	0.98	6.11	1.06	6.62	16.04

TABLE VI.—*Tree No. 2.*

II	1*s*	30	3.0	7.65	0.18	3.95	0.20	4.29	4.56
	2*s*	26	2.7	8.19	0.28	2.80	0.31	3.05	10.00
	1*h*	34	3.5	7.31	1.44	9.25	1.55	10.10	15.35
	2*h*	30	5.0	8.11	1.77	13.05	1.93	14.19	14.41
	3*h*	30	6.0	8.16	1.27	8.06	1.39	8.78	15.75
	4*h*	11	4.2	7.88	1.07	8.24	1.16	8.94	12.99
III	1*s*	30	2.7	8.00	0.16	1.79	0.18	1.95	8.94
	2*s*	36	3.0	8.01	0.22	2.06	0.24	2.24	10.06
	1*h*	33	3.2	7.44	1.25	8.46	1.37	9.14	14.77
	2*h*	28	5.5	7.78	0.85	5.44	0.92	5.89	15.61
	3*h*	17	4.8	7.12	0.80	6.87	0.86	7.40	11.64
IV	1*s*	30	2.7	8.20	0.28	2.31	0.31	2.52	12.12
	2*s*	36	3.0	8.08	0.31	2.49	0.34	2.71	12.36
	1*h*	30	3.6	8.10	1.04	7.44	1.13	8.10	13.98
	2*h*	30	7.6	7.81	0.80	5.91	0.87	6.41	13.53

TABLE VII.—*Trees 54, 55, 56, and 57.*

Serial No. of trees.	No. of disk.	No. of rings.	Width.	Water.	Volatile hydrocarbons.	Rosin.	Calculated for wood free from moisture. Vol. hydr.	Calculated for wood free from moisture. Rosin.	$\frac{\text{Vol. hydr.}}{\text{Rosin.}} \times 100$
			Cm.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
54 55 56 57	II, S.	73 72 48 58	3.8 5.4 4.8 3.0	7.10	0.18	1.37	0.20	1.48	13.14
54 55 56 57	II, 1*h*.	90 90 33 41	10.5 8.4 6.5 5.8	7.11	1.08	6.30	1.16	6.78	17.14
54 55 56 57	II, 2*h*.	31 40 15 70	10.5 8.4 6.5 5.8	6.68	0.65	4.64	0.70	4.97	14.01
54 55 57	III, S.	68 65 52	3.0 5.8 5.0	6.65	0.24	1.80	0.26	1.93	13.33
54 55 57	III, 1*h*.	85 92 60	9.5 8.5 5.0	7.09	0.75	4.46	0.81	4.80	16.82
54 55 57	III, 2*h*.	32 41 68	9.5 8.5 5.0	7.46	0.31	2.75	0.34	2.97	11.27

TABLE VIII.—*Trees 58 and 59.*

58 59	II. S.	56 68	5.7 5.5	6.48	0.26	1.65	0.28	1.76	15.76
58 59	II. H.	52 24	7.0 5.5	7.04	0.74	3.77	0.8	4.06	19.63
58 59	III, S.	60 87	5.2 6.0	7.20	0.18	1.25	0.20	1.35	14.14
58 59	III, H.	58 23	7.0 5.5	7.27	0.76	3.98	0.82	4.29	19.10

TABLE IX.—*Trees 63, 64, and 65.*

Serial No. of trees.	No. of disk.	No. of rings.	Width.	Water.	Volatile hydrocarbons.	Rosin.	Calculated for wood free from moisture. Vol. hydr.	Calculated for wood free from moisture. Rosin.	$\frac{\text{Vol. hydr.}}{\text{Rosin.}}\times 100$
			Cm.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
63 64 65	II, S.	63 95 50	5.2 3.0 6.6	8.02	0.16	1.60	0.18	1.74	10.00
63 64 65	II, 1*h*.	106 53 20	10.0 6.0 4.5	8.20	0.74	3.99	0.81	4.35	18.55
63 64 65	II, 2*h*.	41 21 18	10.0 6.0 4.5	7.68	0.92	5.81	1.00	6.29	15.80

TABLE X.—*Trees 66, 67, 68, and 69.*

66 67 68 69	II, S.	48 60 50 36	7.0 6.5 3.3 3.0	8.35	0.13	1.63	0.14	1.78	8.00
66 67 68 69	II. H.	30 27 21 48	4.8 8.0 2.5 7.5	7.03	0.83	4.60	0.89	4.95	18.00

TABLE XI.—*Trees, 17, 18, 19.*

17 18 19	II, S.	42 67 64	4.0 6.8 7.6	8.45	0.13	1.36	0.14	1.49	9.56
17 18 19	II, 1*h*.	48 63 37	6.6 10.0 6.5	8.18	0.72	3.19	0.78	3.48	22.81
17 18 19	II, 2*h*.	46.3 37 20	6.6 10.0 6.5	8.16	0.45	2.27	0.50	2.47	19.82
17 18 19	III, S.	38 63 73	3.7 6.3 8.2	8.31	0.10	1.22	0.11	1.34	8.20
17 18 19	III, 1*h*.	53 55 37	7.0 6.5 6.3	7.95	0.84	3.34	0.91	3.63	25.15
17 18 19	III, 2*h*.	46 40 27	7.0 6.5 6.3	8.26	0.47	2.56	0.50	2.79	18.36

TABLE XII.—*A summary of results in Tables VII to XI.*

Serial No. of trees.	Part of disk.	Disc II. Volatile hydrocarbons	Disc II. Rosin.	Disc II. $\frac{\text{Vol. hydr.}}{\text{Rosin.}}\times 100$	Disc III. Volatile hydrocarbons	Disc III. Rosin.	Disc III. $\frac{\text{Vol. hydr.}}{\text{Rosin.}}\times 100$
		Per cent.	*Per cent.*		*Per cent.*	*Per cent.*	
54, 55, 56, 57	S.	0.18	1.48	13.14	0.26	1.93	13.33
	1*h*. } H.	1.16 } 0.93	6.78 } 5.88	17.14 } 15.58	0.81 } 0.58	4.80 } 3.89	16.82 } 14.04
	2*h*.	0.70	4.97	14.01	0.34	2.97	11.27
58, 59	S.	0.28	1.76	15.76	0.20	1.35	14.14
	H.	0.80	4.06	19.63	0.82	4.29	19.10
63, 64, 65	S.	0.18	1.74	70.00	....	....	....
	1*h*. } H.	0.81 } 0.91	4.35 } 5.32	18.55 } 17.18	....	....	....
	2*h*.	1.00	6.29	15.80			
66, 67, 68, 69	S.	0.14	1.78	8.00	....	....	....
	H.	0.89	4.95	18.00	....	....	....
17, 18, 19	S.	0.14	1.49	9.56	0.11	1.34	8.20
	1*h*. } H.	0.78 } 0.64	3.48 } 2.98	22.87 } 21.37	0.91 } 0.71	3.63 } 3.21	25.15 } 21.76
	2*h*.	0.50	2.47	19.82	0.50	2.79	18.36

FIELD RECORDS OF TEST MATERIAL.

By Charles Mohr.

Species: *Pinus Palustris.*

STATION (denoted by capital letter): *A.*

State: *Alabama.* County: *Escambia.* Town: *Wallace.*

Longitude: *86° 12'.* Latitude: *31° 15'.* Average altitude: *75 to 100 feet.*

General configuration: Plain—hills—plateau—mountainous. General trend of valley or hills: *Low undulations with broad, expanded ridges.*

Climatic features: *Subtropical*; mean annual temperature, *65°*; mean annual rainfall, *62 inches.*

SITE (denoted by small letter): *a.*

Aspect: Level *almost*—ravine—cove—bench—slope (angle approximately).

Exposure: .... Elevation (above average station altitude): *125 feet.*

Soil conditions:

(1) Geological formation (if known): *Southern stratified drift.*

(2) Mineral composition: Clay—limestone—loam—marl—sandy loam—loamy sand—sand—gravelly.

(3) Surface cover: Bare—grassy—mossy. Leaf cover: Abundant—moderate—scanty—lacking.

(4) Depth of vegetable mold (humus): Absent *almost*—moderate—plenty—or give depth in inches.

(5) Grain, mechanical conditions, and admixtures: Very fine—fine—medium—coarse—porous—light—loose—moderately loose—compact—binding—stones or rock, size of: ....

(6) Moisture conditions: Wet—moist—fresh—dry—arid—well drained—liable to overflow—swampy—near stream or spring or other kind of water supply ....

(7) Color: *Ashy gray.*

(8) Depth to subsoil (if known): Shallow (*3 to 4* inches to 1 foot)—deep, (1 foot to 4 feet)—very deep, (over 4 feet)—shifting.

(9) Nature of subsoil (if ascertainable): *Red ferruginous sandy loam, moderately loose, or rather slightly binding, always of some degree of dampness, of great depth.*

Forest conditions: Mixed timber—pure—dense growth—moderately dense—open.

Associated species: *None.*

Proportions of these: ....

Average height: *90 feet.*

Undergrowth: Dense—scanty, *in the original forest often none*—kind: ....

Conditions in the open: Field—pasture—lawn—clearing (how long cleared): *In natural clearing, untouched by fire, dense groves of second growth of the species.*

Nature of soil cover (if any): Weeds—brush—sod.

STATION: A. SITE: *a.* SPECIES: *Pinus palustris.* TREE NO.: 1.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to rather light or dense position, etc., protected by buildings).
ORIGIN of tree (if ascertainable, natural seeding, sprout from stump, artificial planting).

DIAMETER breast high: 19 inches.
HEIGHT to first limb: 70 feet.
AGE (annual rings on stump): 182.
HEIGHT OF STUMP: 18 inches.
LENGTH OF FELLED TREE: 111 feet.
TOTAL HEIGHT: 113 feet.

NOTE.—As much as possible make description by underscoring terms used above. Add other descriptive terms if necessary.

No. of disks.	Distance from butt.	Weight of combined disk pieces.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter, butt end.	Position.
	Feet.	*Pounds.*			*Ft. In.*	*Ft. In.*	*Inches.*	
I	0	33	Crown slightly covered; distance from nearest timber tree, 20 to 50 feet; crown not perfect; limbs greatly shattered by fall.	I	0 8	12 4	19	
II	13	26		II	13 8	5 4	$15\frac{3}{4}$	
III	19	24		III	19 8	12 4	*$14\frac{3}{8}$	
IV	32	22		IV	32 8	14 4	$13\frac{3}{4}$	
V	47	19		V	47 8	9 4	$13\frac{1}{4}$	
VI	57	20		VI	57 8	9 4	$12\frac{1}{4}$	
VII	67	18		VII	67 8	9 4	$11\frac{1}{2}$	
VIII	77	16		VIII	77 8	5 5	$9\frac{1}{2}$	Butt end.
IX	87	15		IX	87 8	3 5	$8\frac{1}{2}$	Do.
X	97	11		X	97 8	3 6	$7\frac{3}{4}$	Upper end.
XI	107	10		XI	107 8	8 6	$6\frac{1}{2}$	Do.

* Average.

DISTANCE FROM BUTT OF TREE: 98 feet. POSITION ON TRUNK: East. TOTAL LENGTH: 11 feet.
NUMBER of disks taken: Two.
No. I, disk X. Weight, $2\frac{1}{2}$ pounds.
No. II, disk X, distance of tree from trunk, 5 feet 6 inches. Weight, $1\frac{3}{4}$ pounds.

REMARKS.—Top of tree and limbs much shattered by fall. Upper part of logs VIII and IX rejected. Lower end of logs IX and X rejected.

STATION: A. SITE: *a*. SPECIES: *Pinus palustris*. TREE NO.: 2.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings): Distance from nearest timber trees, from 18 to 30 feet; moderatly dense for the species.
ORIGIN of tree (if ascertainable, natural seeding, sprout from stump, artificial planting).

DIAMETER breast high: $18\frac{1}{2}$ inches.
HEIGHT to first limb: 62 feet.
AGE (annual rings on stump): 196.
HEIGHT OF STUMP: 20 inches.
LENGTH OF FELLED TREE: 111 feet.
TOTAL HEIGHT: 113 feet.

No. of disks.	Distance from butt.	Weight of combined disk pieces.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter, butt end.
	Feet.	*Pounds.*			*Ft. In.*	*Ft. In.*	*Inches.*
I	0	33	Crown entirely free.	I	0 8	12 4	19
II	13	26		II	13 8	5 4	$13\frac{3}{4}$
III	19	24		III	19 8	12 4	$14\frac{3}{8}$
IV	32	22		IV	32 8	14 4	$13\frac{3}{4}$
V	47	19		V	47 8	9 4	$13\frac{1}{4}$
VI	57	20		VI	57 8	9 4	$12\frac{1}{4}$
VII	67	18		VII	67 8	9 4	$12\frac{1}{2}$
VIII	77	17		VIII	77 8	9 4	$11\frac{3}{8}$
IX	87	14		IX	87 8	9 4	$8\frac{3}{4}$
X	97	7		X	97 8	7 11	$5\frac{3}{8}$

DISTANCE FROM BUTT OF TREE: 90 feet. POSITION ON TRUNK: Northeast. TOTAL LENGTH: 19 feet.
NUMBER of disks taken: 3.

NOTE.—Upper end of log X rejected.

STATION: A. SITE: *a*. SPECIES: *Pinus palustris*. TREE NO.: 3.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or rather dense for this species, position, etc., protected by buildings).
ORIGIN of tree (if ascertainable, natural seeding, sprout from stump, artificial planting).

DIAMETER breast high: 16 inches.
HEIGHT to first limb: 53 feet.
AGE (annual rings on stump): 183.
HEIGHT OF STUMP: 20 inches.
LENGTH OF FELLED TREE: 110 feet 4 inches.
TOTAL HEIGHT: 111 feet 8 inches.

No. of disks.	Distance from butt.	Weight of combined disk pieces.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter, butt end.	Position.
	Feet.	*Pounds.*			*Ft. In.*	*Ft. In.*	*Inches.*	
I	0	27	Crown touching those of nearest trees to the N. and NE.; open toward SW.	I	0 8	12 4	$16\frac{3}{4}$	
II	13	20		II	13 8	5 4	$14\frac{1}{2}$	
III	19	20		III	19 8	12 4	14	
IV	32	18		IV	32 8	14 4	$13\frac{1}{2}$	
V	47	16		V	47 8	9 4	$12\frac{1}{4}$	
VI	57	14		VI	57 8	9 4	$11\frac{1}{3}$	
VII	67	17		VII	67 8	9 4	$9\frac{3}{4}$	
VIII	77	14		VIII	77 8	9 4	$8\frac{1}{2}$	
IX	87	$9\frac{1}{2}$		IX	87 8	3 6	7	Butt end.
X	97	6		X	97 8	3 3	5	Do.

DISTANCE FROM BUTT OF TREE: 98 feet. POSITION ON TRUNK: South. TOTAL LENGTH: 15 feet.
NUMBER of disks taken: 2.
Disk No. I, distant from trunk of tree 4 inches. Weight, 3 pounds.
Disk No. II, distant from trunk of tree 5 feet 4 inches. Weight, 2 pounds.

REMARKS.—The upper ends of logs IX and X rejected.

STATION: A. SITE: *a*. SPECIES: *Pinus palustris*. TREE NO.: 4.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense for the species, position, etc., protected by buildings).
ORIGIN of tree (if ascertainable, natural seeding, sprout from stump, artificial planting).

DIAMETER breast high: 19 inches. HEIGHT OF STUMP: 1 foot 10 inches.
HEIGHT to first limb: 57 feet. LENGTH OF FELLED TREE: 109 feet.
AGE (annual rings on stump): 189. TOTAL HEIGHT: 111 feet.

No. of disks.	Distance from butt.	Weight of combined disk pieces.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter, butt end.	Position.
	Feet.	*Pounds.*			*Ft. In.*	*Ft. In.*	*Inches.*	
I	0	28	Crown partially covered, poorly developed limbs gnarled, below normal average length.	I	0 8	12 4	19	
II	13	25		II	13 8	5 4	18	
III	19	23		III	19 8	12 4	17	
IV	32	23		IV	32 8	14 4	16¼	
V	47	19		V	47 8	9 4	15⅛	
VI	57	18		VI	57 8	9 4	13¾	
VII	67	16		VII	67 8	9 4	12½	
VIII	77	16		VIII	77 8	5 4	11½	Top end.
IX	87	14		IX	87 8	9 4	9½	
X	97	6		X	97 8	5 4	5½	Do.

DISTANCE FROM BUTT: 93 feet. POSITION ON TRUNK: Northeast. TOTAL LENGTH: 15 feet.
NUMBER of disks taken: 2.
No. I, disk distant from trunk of tree, 5 feet.

REMARKS.—Of logs VIII and X butt ends were rejected, having been badly shattered.

STATION: A. SITE: *a*. SPECIES: *Pinus palustris*. TREE NO.: 5 X.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings). Almost level, with slight incline N. Open distance of nearest tree, 25 to 50 feet.
ORIGIN of tree (if ascertainable; natural seeding, sprout from stump, artificial planting).
DIAMETER breast high: 26¾ inches. HEIGHT OF STUMP: 1 foot 2 inches.
HEIGHT to first limb: 53 feet. LENGTH OF FELLED TREE: 105 feet.
AGE (annual rings on stump): 216. TOTAL HEIGHT: 106 feet.

No. of disks.	Distance from butt.	Weight of combined disk pieces.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.
	Feet.	*Pounds.*			*Ft. In.*	*Ft. In.*	*Inches.*
I	2	40	Crown free from all sides; *perfectly* developed with rich foliage; wood resinous. Some perhaps more resinous on account of the full development of numerous lateral ones and fuller leaved branches are distinguished by the lumbermen as *pitch pines*. The timber trees of a less resinous wood being called yellow (long leaved) pines. Position of largest limb north; at least 35 feet long.	I	2 8	5 4	27
II	8	35		II	8 8	5 4	24
III	14	33		III	14 8	6 4	22⅝

REMARKS.—The stump was found defective in the center; the disk affected near the center by an apparently slight "*ringshake*." The following sections showing the same defect in a small and decreasing degree toward the top. According to the information of logmen and manufacturers this defect is not regarded as a material injury to the quality of the timber, and never causes its *under* classification. On the broad level expanses of the undulating uplands most exposed to wind, hundreds of trees of such dimension and ripeness of age might be felled before one is found to be absolutely free from such *ringshake*.

Species: ***Pinus palustris.***

STATION (denoted by capital letter): *B.*

State: *Alabama.* County: *Clark.* Town: *Thomasville.*

Longitude: *86° 45′.* Latitude: *32° 4′.* Average altitude: *380 feet.*

General configuration: Plain—hills—plateau—mountainous. General trend of valleys or hills: *E, S, E. to NW.*

Climatic features: *subtropical;* mean annual temperature, *66° F.;* mean annual rainfall, *56 to 60 inches.*

SITE (denoted by small letter): *a.*

Aspect: Level—ravine—cove—bench—slope (angle approximately: *20° to 40°*).

Exposure: .... Elevation (above average station altitude): *250 feet.*

Soil Conditions:

(1) Geological formation (if known): *Lowest Eocene. Buhrstone.*

(2) Mineral composition: Clay—limestone—loam—marl—sandy loam—loamy sand—sand—gravelly.

(3) Surface cover: Bare—*somewhat* grassy—mossy. Leaf cover: Abundant—moderate—scanty—lacking.

(4) Depth of vegetable mold (humus): Absent—moderate—plenty—or give depth in inches ....

(5) Grain, mechanical conditions, and admixtures: Very fine—fine—medium—coarse—porous—light—loose—moderately loose—compact—binding—stones or rock, size of: ....

(6) Moisture conditions: Wet—moist—fresh—dry—arid—well drained—liable to overflow—swampy—near stream or spring or other kind of water supply ....

(7) Color: *Ashy.*

(8) Depth to subsoil (if known): Shallow, (6 inches to 1 foot)—deep, (2 feet to 4 feet) very deep, (over 4 feet)—shifting.

(9) Nature of subsoil (if ascertainable): *fine, sandy, red ferrugent.*

Forest conditions: Mixed timber—pure—dense growth—moderately dense—open ....

Associated species: *Black Jack, Spanish Oak, Dogwood, Black gum.*

Proportions of these: *All equally in very small proportions. Not reaching 10 per cent.*

Average height: *30 to 40 feet.*

Undergrowth: Dense—scanty—kind: *Scrubby growth of above hardwoods, with Vaccinium Staminlum.*

Conditions in the open: Field—pasture—lawn—clearing (how long cleared): *Pinus Taeda with P. eschinater, cleared scarcely over 25 years.*

Nature of soil cover (if any): Weeds—brush—sod. *Brush of pines and hardwoods. Pinus palustris rarely seen amongst it, and of crippled growth.*

STATION: B. SITE: *a.* SPECIES: *Pinus palustris.* TREE NO.: 16.

POSITION of tree (if any special points notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings), on gentle decline W. S. W., *crown partially covered N. to E.* not touching and free S. and W.

ORIGIN of tree (if ascertainable; natural seeding, sprout from stump, artificial planting.)

DIAMETER breast high: 20 inches.
HEIGHT to first limb: 56 feet.
AGE (annual rings on stump): 202.

HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 105 feet.
TOTAL HEIGHT: 108 feet.

No. of disks.	Distance from butt.	Weight of combined disk pieces.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.	Annual rings at butt end.
	Ft. In.	*Lbs. Oz.*			*Ft. In.*	*Feet.*	*Inches.*	
I.	0 9	24 0	All disks measured 6 inches in height.	I.	0 15	12	20	200
II.	19 3	18 7		II.	13 3	6	19½	....
III.	31 9	15 0	15½ inches.	III.	19 9	12	16	196
IV.	44 3	14 3	12½ inches.	IV.	32 3	12	15	....
V.	54 3	13 4	12 inches.					
VI*	64 3	....	....					
VII.	74 9	7 0	8½ inches.					

* Rejected, too knotty for splitting.

No. II, no disk taken, radical fissure above butt cut very small, timber sound, without limb knot to length of 44 feet.

STATION: B. SITE: *a.* SPECIES: *Pinus palustris.* TREE NO.: 17.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings). Near top of ridge, slight western decline, crown not touching with nearest trees of similar height, which are from 40 to 50 feet distant.

ORIGIN of tree (if ascertainable; natural seeding, sprout from stump, artificial planting.)

DIAMETER breast high: 21 inches.
HEIGHT to first limb: 53 feet.
AGE (annual rings on stump): 163.

HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 112 feet.
TOTAL HEIGHT: 115 feet.

NOTE.—As much as possible make description by underscoring terms used above. Add other descriptive terms if necessary.

No. of disks.	Distance from butt.	Weight of combined disk pieces.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.	Annual rings at butt end.
	Ft. In.	*Lbs. Oz.*			*Ft. In.*	*Feet.*	*Inches.*	
I	5 0	33 8	Disks, as in all following mature trees, 8 inches high. Five above butt cut rejected on account of wind shake and radial fissures.	I	5 8	12	20	156
				II	18 4	6	$17\frac{1}{2}$	154
				III	25 0	1	16	152
II	17 8	26 12						
III	24 4	26 2						
IV	37 0	24 3						
V	51 8	20 4	13 inches.					
VI	62 4	20 1	12 inches.					
VII	73 0	19 0	12 inches.					

The fourth log, 14 feet long and $15\frac{1}{2}$ inches in diameter, had to be discarded on account of frequent small limb knots, not discovered until its intended removal; length of timber free from any knot little less than 40 feet, furnishing lumber of low grades to length of 50 feet above butt cut.

STATION B. SITE *a.* SPECIES: *Pinus palustris.* TREE NO. 18.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings). On gentle slope to S. W., crown touching N. to E. Exposed S. and west.
ORIGIN of tree (if ascertainable, *natural seeding*, sprout from stump, artificial planting).

DIAMETER breast-high: 22 inches.
HEIGHT to first limb: 47 feet.
AGE (annual rings on stump): 210.

HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 107 feet.
TOTAL HEIGHT: 110 feet.

No. of disks.	Distance from butt.	Weight of combined disk pieces.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter, butt-end.
	Ft. In.	*Lbs. Oz.*			*Ft. In.*	*Feet.*	*Inches.*
I	5 0	28 4	First 5 feet above butt-cut rejected on account of central small wind shake (ring shake).	I	5 8	12	$21\frac{1}{2}$
II	17 8	30 6		II	18 4	12	$21\frac{1}{2}$
				III	33 0	6	20
III	32 4	27 12	Two feet above log thrown out on account of limb knot.				
IV	39 0	29 10					
V	53 0	25 11					
VI	68 4	23 8					

Above log No. III, numerous small limb knots up to first limb. No further log of the required length could be obtained.

STATION B. SITE *a.* SPECIES: *Pinus palustris.* TREE NO. 19: ("Check tree.")

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings). On gentle southern decline. Crown free from all sides. Surrounded by several trees of almost equal dimensions, but not touching.
ORIGIN of tree (if ascertainable: natural seeding, sprout from stump, artificial planting).

DIAMETER breast-high: 26 inches.
HEIGHT to first limb: 43 feet.
AGE (annual rings on stump): 160.

HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 108 feet.
TOTAL HEIGHT: 111 feet.

No. of disks.	Distance from butt.	Weight of combined disk pieces.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter, butt-end.	Annual rings at butt end.
	Ft. In.	*Lbs. Oz.*			*Ft. In.*	*Ft. In.*	*Inches.*	
I	0 0	44 0	Of vigorous growth above butt-cut, with very slight radial fissures which completely disappeared before reaching log No. II. No cause can be given for its rapid growth if it is not to be ascribed to the southern and freer exposure.	I	0 8	12 0	26	155
II	12 8	35 13		II	13 4	12 0	$23\frac{3}{4}$	146
III	25 4	35 10		III	26 0	13 8	$22\frac{1}{2}$	136
IV	39 8	31 7						
V	49 8	27 —						
VI	59 8	25 8						
VII	70 4	24 3						
VIII	80 0	17 3						

Log No. II or III, from all appearances perfectly solid and without any wind shake. Might serve for 6-foot check log and 6-foot log for Mr. Roth.

STATION B. SITE *a.* SPECIES: *Pinus palustris.* TREE NO. 20.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings). On slope of a section of about 20 degrees; southern exposure; crown *free* S. to S. W., slightly touching N. to N. E.
ORIGIN of tree (if ascertainable: *natural seeding,* sprout from stump, artificial planting).

DIAMETER breast-high: 17 inches.
HEIGHT to first limb: 36 feet.
AGE (annual rings on stump): 110.
HEIGHT OF STUMP: 2 feet 9 inches.
LENGTH OF FELLED TREE: 89 feet 3 inches.
TOTAL HEIGHT: 92 feet.

No. of disks.	Distance from butt.	Weight of combined disk pieces.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter, butt-end.	Annual rings at butt end.
	Ft. In.	*Lbs. Oz.*			*Ft. In.*	*Ft. In.*	*Inches.*	
I	0 0	31 12	Perfectly free from wind shake; of sturdy growth; free from any knots to the height of 32 feet in felled tree.	I	0 8	12 0	17	110
II	12 8	25 11		II	13 4	18 8	16¼	107
III	32 —	25 3						
IV	42 4	21 3						

Species: *Pinus palustris.*

STATION (denoted by capital letter): *A.*

State: *Alabama.* County: *Escambia.* Town: *Wilson.*

Longitude: *87° 34′.* Latitude: *31° 2″.* Average altitude: *230.*

General configuration: *Level, or undulating, or low.* Plain—hills—plateau—mountainous. General trend of valleys or hills, *Southern.*

Climatic features: *Subtropical;* mean annual temperature, *65°;* mean annual rainfall, *55 to 60 inches.*

SITE (denoted by small letter): *a.*

Aspect: Level—ravine—cove—bench—slope (angle approximately *upland*). *Turpentine orchard abandoned 1886.*

Exposure: .... Elevation (above average station altitude), *about 30 feet.*

Soil conditions:

(1) Geological formation (if known): *Post-tertiary, Orange or Lafayette, sands of stratified southern drift.*

(2) Mineral composition: Clay—limestone—loam—marl—sandy loam—loamy sand—sand—gravelly.

(3) Surface cover: Bare—grassy—mossy. Leaf cover: Abundant—moderate—scanty—lacking.

(4) Depth of vegetable mold (humus): Absent—very moderate—plenty—or give depth in inches: *about 3 inches mixed with soil.*

(5) Grain, mechanical conditions, and admixtures: Very fine—fine—medium—coarse—porous—light—loose—moderately loose—compact—binding—stones or rock, size of........................

(6) Moisture conditions: Wet—moist—fresh—dry—arid—well drained—liable to overflow—swampy—near stream or spring or other kind of water supply........................

(7) Color: *Ashy gray.*

(8) Depth to subsoil (if known): Shallow (*3 to 4 inches* to 1 foot)—deep, (1 foot to 4 feet)—very deep (over 4 feet)—shifting.

(9) Nature of subsoil (if ascertainable)........................

Forest conditions: Mixed timber—pure—dense growth—moderately dense—open *loamy yellow sand for 1 foot, followed by coarser sandy loam, irregularly traversed by ledges of compact ferruginous conglomerate.*

Associated species: *None.*

Proportions of these........................

Average height............

Undergrowth: Dense—scanty—kind: *Scrubby Black Jack, Blue Jack, Barren and Post Oak.*

Conditions in the open: Field—pasture—lawn—clearing (how long cleared): *Dense growth of species.*

Nature of soil cover (if any): Weeds—brush—sod.
(*rarely*)

The undergrowth of scrub oak scarcely exceeds 2 feet in height.

NOTE.—As much as possible make description by underscoring terms used above. Add other descriptive terms if necessary.

STATION: E. SITE: *a*. SPECIES: *Pinus palustris*. TREE NO.: 52.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks).
ORIGIN of tree (if ascertainable, *natural seeding*, sprout from stump, artificial planting).

DIAMETER breast high: 28¼ inches clear of bark.
HEIGHT to first limb: 61 feet.
AGE (annual rings on stump): —.
HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 108 feet.
TOTAL HEIGHT: 111 feet.

No. of disks.	Distance from butt.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.	Annual rings at butt end.
	Ft. In.			*Ft. In.*	*Feet.*	*Inches.*	
I	0 0	Slight ring shake.	I	0 6	20	29	Slight ring shake.
II	20 6		II	21	12	24	
III	33 0						
IV	43 0						
V*	53 0						
VI	63 0						
VII	73 0						
VIII	83 0						

*Rejected; central knots.

Remarks on situation, exposure, etc.—Good pine land, well timbered. On gentle slope towards the north and west; trunk bearing two boxes, chip from 5 to 6 feet high (to base of box), and chipped for fully four seasons; near middle of chip on the callus, the sapwood in one place perforated by borers, not penetrating to the heartwood which, with the exception of a slight ring shake near the center, is perfectly sound to a height of over 43 feet.

STATION: E. SITE: *a*. SPECIES: *Pinus palustris*. TREE NO.: 53.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks).
ORIGIN of tree (if ascertainable, *natural seeding*, sprout from stump, artificial planting).

DIAMETER breast high: 29 inches.
HEIGHT to first limb: 30 feet.
AGE (annual rings on stump): 192.
HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 115 feet.
TOTAL HEIGHT: 118 feet.

No. of disks.	Distance from butt.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.	Annual rings at butt end.
	Ft. In.		*Ft. In.*	*Feet.*	*Inches.*	
I	0 0	I	0 6	20	30	192
II	20 6	II	43 6	12	22	
III	43 0					
IV	55 0					
V	65 0					

Remarks on situation, exposure, etc.—Situated on first-class pine land, well timbered, luxuriant in grass and herbage, about 300 yards distant from branch; on a gentle decline to the west, near large pines in the open forest allowing free exposure in every direction; no undergrowth. One large limb 30 feet above butt end; perfectly clear from there for next 12 feet. Sapwood slightly rotten on the surface in consequence of a deep burn; slightly cracked in the base of first log, and with a few splinter holes, insignificant injuries, caused in felling the tree; besides, the timber was found perfectly solid and sound. Boxes, two.

STATION: E. SITE: *a*. SPECIES: *Pinus palustris*. TREE NO.: 54.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks).
ORIGIN of tree (if ascertainable, *natural seeding*, sprout from stump, artificial planting).

DIAMETER breast high: 23 inches.
HEIGHT to first limb: 66 feet.
AGE (annual rings on stump): 180.
HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 102 feet.
TOTAL HEIGHT: 105 feet.

No. of disks.	Distance from butt.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.	Annual rings at butt end.
	Ft. In.		*Inches.*	*Feet.*	*Inches.*	
I	0 0	I	6	12	21	180
II	12 6					

Remarks on exposure, situation, etc.—Situated on a broad ridge forming a table-land several hundred acres in extent, of average good quality, well timbered, with a number of trees of and below medium size; soil covered with grass and herbage; crown not fully exposed, but not touched by the trees next by. A most sound tree, apparently without flaw for the length of 50 feet above the cut to the first few small limb knots. Bearing two boxes.

STATION: E. SITE: *a*. SPECIES: *Pinus palustris*. TREE NO.: 55.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks.)
ORIGIN of tree (if ascertainable, *natural seeding*, sprout from stump, artificial planting).

DIAMETER breast high: 21 inches.
HEIGHT to first limb: 59 feet.
AGE (annual rings on stump): —.
HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 111 feet.
TOTAL HEIGHT: 114 feet.

No. of disks.	Distance from butt.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.
	Ft. In.			*Ft. In.*	*Feet.*	*Inches.*
I	12	The first foot above cut rejected on account of central ring shake and eccentric cracks.	I	1 6	12	20¾
II	13 6					

Remarks on situation, exposure, etc.—Flat, broad, extensive ridge, among trees similar in size, crown not exposed but not touching; boxes, two; timber in log perfectly sound; pine land of good average quality and well timbered.

STATION: E. SITE: *a*. SPECIES: *Pinus palustris*. TREE NO.: 56.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks).
ORIGIN of tree (if ascertainable, *natural seeding*, sprout from stump, artificial planting).

DIAMETER breast high: 16¼ inches.
HEIGHT to first limb: 57 feet.
AGE (annual rings on stump): —.
HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 97 feet.
TOTAL HEIGHT: 100 feet.

No. of disks.	Distance from butt.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.
	Ft. In.			*Inches.*	*Feet.*	*Inches.*
I	....	Perfectly sound in heartwood; sound and resinous; slightly wind shaken.	I	6	12	16
II	12 6					
III	22 6					

Remarks on situation, exposure, etc.—On good pine land rather closely timbered, flat, wide, extended back of ridge, from a group of trees varying from 10 to 16 inches in diameter; crown not fully exposed; boxed on two sides; timber showing in log no sign of injury or decay.

STATION: E. SITE: *a*. SPECIES: *Pinus palustris*. TREE NO.: 57.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks).
ORIGIN of tree (if ascertainable, *natural seeding*, sprout from stump, artificial planting).

DIAMETER breast high: 14½ inches.
HEIGHT to first limb: 33 feet.
AGE (annual rings on stump): —.
HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 67 feet.
TOTAL HEIGHT: 70 feet.

No. of disks.	Distance from butt.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.
	Ft. In.			*Inches.*	*Feet.*	*Inches.*
I	....	Diameter 14½, with slight radial wind shake through center; 14 inches; sound.	I	6	12	14½
II	12 6					

Remarks on situation, exposure, etc.—On broad extended ridge; partially shaded by larger pines somewhat freely exposed to the north. One box.

STATION: E. SITE: *a*. SPECIES: *Pinus palustris*. TREE NO.: 58.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks).
ORIGIN of tree (if ascertainable): Natural seeding, sprout from stump, artificial planting.

DIAMETER breast high: 12 inches.
HEIGHT to first limb: 43 feet.
AGE (annual rings on stump):
HEIGHT of stump: 3 feet.
LENGTH of felled tree: 87 feet.
TOTAL HEIGHT: 90 feet.

No. of disks.	Distance from butt.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter, butt end.
	Ft. In.			*Inches.*	*Feet.*	*Inches*
I	....	Diameter, 12 inches; sound.	I	6	12	12
II	12 6	Diameter, 11½ inches; sound.				
III	24 6	Diameter, 11 inches; sound.				

Remarks on situation and exposure.—On broad ridge: from a dense grove of trees of about the same dimensions grown in contact with that of trees of similar height. One box.

STATION: E. SIZE: *a.* SPECIES: *Pinus palustris.* TREE NO.: 59.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks).
ORIGIN of tree (if ascertainable), natural seeding, sprout from stump, artificial planting.

DIAMETER breast high: 12 inches.
HEIGHT to first limb: 46 feet.
AGE (annual rings on stump):

HEIGHT of stump: 3 feet.
LENGTH of felled tree: 88 feet.
TOTAL HEIGHT: 91 feet.

No. of disks.	Distance from butt.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.
	Ft. In.			*Inches.*	*Feet.*	*Inches.*
I	....	Diameter, 12 inches.	I	6	12	12
II	12 6	Diameter, $10\frac{1}{2}$ inches.				
III	24 6	Diameter, 10 inches.				

Remarks on situation and exposure.—Both the same as in tree 58.

Species: *Pinus palustris (boxed timber from turpentine orchard).*

STATION (denoted by capital letter): *A.*

State: *Alabama.* County: *Escambia.* Town: *Wilson.*

Longitude: *87° 34′.* Latitude: *31° 2′.* Average altitude: *230 ft.*

General configuration: Plain, *undulating or flat, low* hills—plateau—mountainous. General trend of valleys or hills; *South.*

Climatic features: *Subtropical;* mean annual temperature, *65°;* mean annual rainfall, *60 in.*

SITE (denoted by small letter): *a. Turpentine orchard abandoned 1890.*

Aspect: Level—ravine—cove—bench—slope (angle approximately).

Exposure: .... Elevation (above average station altitude): *30 feet.*

Soil Conditions:

(1) Geological formation (if known): *Post-tertiary, Orange, or Lafayette. Sands stratified drift of the South.*

(2) Mineral composition: Clay—limestone—loam—marl—sandy loam *to* loamy sand—sand—gravelly.

(3) Surface cover: Bare—grassy—mossy. Leaf cover: Abundant—moderate—*very* scanty—lacking.

(4) Depth of vegetable mold (humus) Absent—moderate—plenty—or give depth in inches: *2 to 3 inches mixed with soil.*

(5) Grain, mechanical conditions, and admixtures: Very fine—fine—medium—coarse—porous—light—loose—moderately loose—compact—binding—stones or rock, size of: *From size of a buckshot to a pigeon egg, mixed with furruginous gravel.*

(6) Moisture conditions: Wet—moist—fresh—dry—arid—well drained—liable to overflow—swampy—near stream or spring or other kind of water supply ....

(7) Color: *Reddish brown.*

(8) Depth to subsoil (if known): Shallow (*below 3 inches* to 1 foot)—deep (1 foot to 4 feet)—very deep (over 4 feet)—shifting.

(9) Nature of subsoil (if ascertainable): *Deep yellow or reddish brown.*

Forest conditions: Mixed timber—pure—dense growth—moderately dense—open—*sandy loam or loamy sand, retentive of moisture and almost to same degree moist.*

Associated species: ....

Proportions of these: ....

Average height: ....

Undergrowth: Dense—scanty—kind: *almost entirely wanting.*

Conditions in the open: Field—pasture—lawn—clearing (how long cleared): *The same as in site a.*

Nature of soil cover (if any): Weeds—brush—sod.

NOTE.—As much as possible make description by underscoring terms used above. Add other descriptive terms if necessary.

STATION: E. SITE: *b*. SPECIES: *Pinus palustris*. TREE NO.: 60.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks).
ORIGIN of tree (if ascertainable, natural seeding, sprout from stump, artificial planting).

DIAMETER breast high: 23 inches.
HEIGHT to first limb: 43½ feet.
AGE (annual rings on stump): 225.

HEIGHT of stump: 3 feet.
LENGTH of felled tree: 114½ feet.
TOTAL HEIGHT: 117 feet.

No. of disks.	Distance from butt.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter, butt end.	Annual rings at butt end.
	Ft. In.			*Ft. In.*	*Feet.*	*Inches.*	
I	0 6	Diameter, clear wood, 23 inches.	I	2 0	20	23	223
II	21 0	Diameter, clear wood, 21 inches.	II	21 6	12	19½	220
III	33 6	Diameter, 19 inches.					
IV	45 0						

Remarks on situation, exposure, etc.—On gravelly ridge, partially covered by equally large trees on the north side, timber with two boxes, chips 17 inches each; sapwood slightly wormeaten along the base of the callus of chip, not penetrating heartwood.

STATION: E. SITE: *b*. SPECIES: *Pinus palustris*. TREE NO.: 61.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks).
ORIGIN of tree (if ascertainable, natural seeding, sprout from stump, artificial planting).

DIAMETER breast high: 26 inches.
HEIGHT to first limb: 64 feet.
AGE (annual rings on stump): 214.

HEIGHT of stump: 3 feet.
LENGTH of felled tree: 117 feet.
TOTAL HEIGHT: 120 feet.

No. of disks.	Distance from butt.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter, butt end.	Annual rings at butt end.
	Ft. In.			*Feet.*	*Feet.*	*Inches.*	
I	0 0	Diameter, 26½ inches.	I	1	20	26½	214
II	21 0	Diameter, 22½ inches.	II	21	12	22½	....
III	33 6	Diameter, 21½ inches.					

Remarks on situation, exposure, etc.—A fine, to all appearances, perfectly sound tree, grown in a shallow depression, with a luxuriant soil cover of grass and but slightly gravelly; surrounded by large trees partially covered to the northward; elsewhere of free exposure. Timber clear of knots for a length of 50 feet. Diameter below crown, 19 inches. Boxes, two.

STATION: E. SITE: *b*. SPECIES: *Pinus palustris*. TREE NO.: 62.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks).
ORIGIN of tree (if ascertainable; natural seeding, sprout from stump, artifical planting).

DIAMETER breast high: 21 inches.
HEIGHT to first limb: 42 feet.
AGE (annual rings on stump):

HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 93 feet.
TOTAL HEIGHT: 96 feet.

No. of disks.	Distance from butt.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.
	Ft. In.			*Inches.*	*Feet.*	*Inches.*
I	0 0	Diameter, 21½ inches.	I	6	12	21½
II	12 6					

Remarks on situation, exposure, etc.—Evidently a perfectly sound tree, clear of knots or limb to the height of 50 feet above cut, with a diameter of 16 inches below crown. On gravelly ridge; on all sides freely exposed. Boxes, two.

STATION: E. SITE: *b*. SPECIES: *Pinus palustris*. TREE NO.: 63.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks).
ORIGIN of tree (if ascertainable; natural seeding, sprout from stump, artificial planting).

DIAMETER breast high: 20 inches.
HEIGHT to first limb: 39 feet.
AGE (annual rings on stump): about 200.

HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 106 feet.
TOTAL HEIGHT: 109 feet.

No. of disks.	Distance from butt.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.	Annual rings at butt end.
	Ft. In.			*Inches.*	*Feet.*	*Inches.*	
I	0 0	Diameter. 20½ inches.	I	6	12	20½	198
II	12 6	Diameter, 20 inches.					

Remarks on situation, exposure, etc.—Timber, to all appearance, perfect; free from knots to the height of 35 feet, with a diameter of 18 inches below crown. On slightly gravelly ridge. Somewhat covered to the eastward. Otherwise exposure perfectly free. Boxed on two sides.

STATION: E. SITE: *b*. SPECIES: *Pinus palustris*. TREE NO.: 64.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks.)
ORIGIN of tree (if ascertainable, natural seeding, sprout from stump, artificial planting).

DIAMETER breast high: 16 inches.
HEIGHT to first limb: 49 feet.
AGE (annual rings on stump):
HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 110 feet.
TOTAL HEIGHT: 113 feet.

No. of disks.	Distance from butt.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.
	Ft. In.			*Inches.*	*Feet.*	*Inches.*
I	0 0	Diameter, 16 inches.	I	6	12	15½
II	12 6	Diameter, 13 inches.				

Remarks on situation, exposure, etc.—Sound tree on slight declivity of gravelly ridge to the north; covered on all sides by crowns of trees of about equal height. One box.

STATION: E. SITE: *b*. SPECIES: *Pinus palustris*. TREE NO.: 65.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks).
ORIGIN of tree (if ascertainable, natural seeding, sprout from stump, artificial planting).

DIAMETER breast high: 15 inches.
HEIGHT to first limb: 34 feet.
AGE (annual rings on stump):
HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 78 feet.
TOTAL HEIGHT: 81 feet.

No. of disks.	Distance from butt.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.
	Ft. In.			*Ft. In.*	*Feet.*	*Inches.*
I	1 0	On account of split in felling: diameter clear of bark, 14 inches.	I	1 6	12	14½
II	13 6	Diameter, 11½ inches.				

Remarks.—Sound, growing on gentle declivity; towards northeast of gravelly ridge; slightly covered to the southeast; otherwise perfectly free of exposure. One box.

STATION: E. SITE: *b*. SPECIES: *Pinus palustris*. TREE NO.: 66.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks).
ORIGIN of tree (if ascertainable, natural seeding, sprout from stump, artificial planting).

DIAMETER breast high: 12 inches.
HEIGHT to first limb: 26 feet.
AGE (annual rings on stump): 91.
HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 65 feet.
TOTAL HEIGHT: 68 feet.

No. of disks.	Distance from butt.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.	Annual rings at butt end.
	Ft. In.			*Inches.*	*Feet.*	*Inches.*	
I	0 0	Diameter, 11 inches.	I	6	12	11	90
II	12 6	Diameter, 9½ inches.					

Remarks on situation, exposure, etc.—On slight northeastern decline of gravelly ridge; wood sappy and very resinous; wood sound. One box.

STATION: E. SITE: *b*. SPECIES: *Pinus palustris*. TREE NO.: 67.

POSITION of tree (if any special point notable not appearing in general description of site, exceptional exposure to light or dense position, etc., protected by buildings, see remarks).
ORIGIN of tree (if ascertainable, natural seeding, sprout from stump, artificial planting).

DIAMETER breast high: 12½ inches.
HEIGHT to first limb: 48 feet.
AGE (annual rings on stump): 116.

HEIGHT OF STUMP: 3 feet.
LENGTH OF FELLED TREE: 84 feet.
TOTAL HEIGHT: 87 feet.

No. of disks.	Distance from butt.	Remarks.	No. of log.	Distance from butt.	Length of log.	Diameter butt end.	Annual rings at butt end.
	Ft. In.			*Inches.*	*Feet.*	*Inches.*	
I	0 0	Diameter, 13¾ inches.	I	6	12	12½	116
II	12 6	Diameter, 12 inches.					

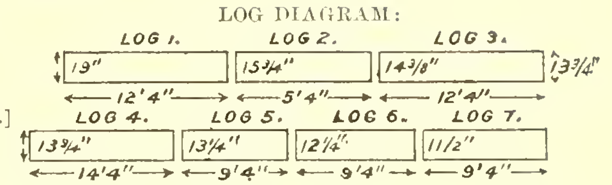
Remarks on situation, exposure, etc.—Same as in 66.

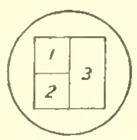
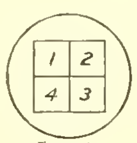
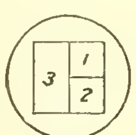
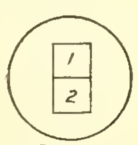
TABLE I.—Condensed Results of Individual Tests on Long-leaf Yellow Pine.

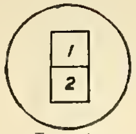
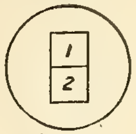
[Reduced results at 15 per cent moisture given in bold-faced type.]

[Species: *Pinus palustris*. Habitat: Wallace, Ala.; upland forest. **TREE No. 1**; cut November, 1890; sawed February, 1891; age, 182 years.]

LOG DIAGRAM:



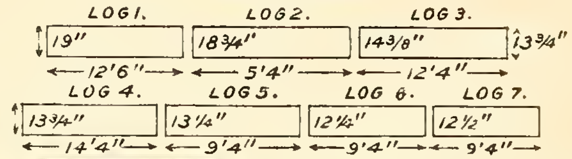
Log number and method of cutting.	No. of stick.	Date of test.	Per-centage of moisture.	Specific gravity.	Cross-bending tests. Dimensions. *l.*	*h.*	*b.*	Modulus of ultimate strength. $f=\frac{3\ W\ l}{2\ b\ h^2}$	Modulus of strength at the elastic limit, per square inch. $f=\frac{3\ W_1\ l}{2\ b\ h^2}$	Modulus of elasticity.	Relative elastic resilience in inch-pounds per cub. inch.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean).	Strength (mean) per square inch.
					In.	*In.*	*In.*	*Pounds.*				*In.*	*Sq. in.*	*Pounds.*	*In.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*
 Log 1.	1	July 25, 1891	20.1	0.785	60	3.41	3.70	10,960	8,580	2,070,000	2.16	8.0	12.58	6,330	3.69	13.40	800	0.903	28,580	4.02	482
								12,935	**9,930**	**2,186,600**	**2.93**			**7,478**			**1,039**				**627**
	1	Aug. 16, 1892	13.1	0.767	60	3.34	3.32	*14,400	9,720	1,790,000	3.49	8.1	11.42	8,740	3.34	13.36	1,155	0.573	28,640	3.62	1,025
								13,094	**8,650**	**1,642,000**	**2.65**			**8,087**			**1,007**				**972**
	2	July 23, 1891	19.9	0.751	60	3.46	3.72	†10,610	8,100	2,100,000	2.07	8.0	12.61	6,220	3.74	14.70	790	0.994	15,390	4.02	796
								12,432	**9,410**	**2,213,300**	**2.83**			**7,331**			**1,021**				**935**
	2	Aug. 16, 1892	11.8	0.776	60	3.64	3.64	14,960	11,940	1,985,000	3.86	8.0	10.56	9,150	3.70	14.62	1,274	0.728	15,500	4.07	552
								12,710	**9,230**	**1,663,800**	**2.43**			**7,878**			**968**				**464**
	3	July 15, 1891	19.4	0.803	144	7.97	3.73	13,220	10,940	2,610,000	1.79	8.1	14.73	‡6,390	3.94	14.65	860	1.058	12,380	4.13	636
								15,002	**12,140**	**2,714,800**	**2.50**			**7,406**			**1,071**				**760**
												37.1	14.28	6,260							
														7,216							
 Log 2.	1	July 9, 1891	18.7	0.731	60	3.40	3.74	11,240	7,080	2,656,000	1.30	8.0	12.97	5,950	3.46	14.73	880	0.90	13,820	4.54	583
								12,814	**8,130**	**2,748,600**	**1.94**			**6,830**			**1,062**				**693**
	2	July 13, 1891	20.2	0.761	60	3.40	3.71	12,320	8,820	2,300,600	2.17	8.0	12.50	6,560	3.72	13.16	900	0.649	21,870	3.91	660
								14,316	**10,190**	**2,418,200**	**2.94**			**7,726**			**1,142**	0.825	24,630		**807**
	3	July 13, 1891	18.9	0.698	60	3.42	3.71	8,710	6,760	1,600,000	1.88	8.0	12.46	5,340	3.72	12.89	600	0.810	22,460	4.44	603
								10,348	**7,860**	**1,696,200**	**2.54**			**6,260**			**791**	0.888	11,940		**714**
 Log 3.	1	Aug. 13, 1891	16.9	0.723	60	3.54	3.73	10,900	7,700	1,630,000	0.98	8.1	12.77	6,610	3.73	13.83	824	0.867	13,840	3.85	754
								11,823	**8,300**	**1,686,400**	**1.39**			**7,100**			**925**				**808**
	1	July 8, 1892	12.7	0.759	60	3.67	3.67	15,160	10,195	1,960,000	3.09	8.0	11.60	8,550	3.70	14.50	1,080	0.618	16,800	3.76	862
								13,564	**8,650**	**1,761,200**	**2.08**			**7,719**			**887**				**797**
	2	July 25, 1891	19.6	0.755	60	3.48	3.75	11,270	7,920	1,670,000	2.39	8.0	12.76	6,080	3.71	13.44	770	0.992	19,750	4.17	524
								13,108	**9,170**	**1,778,200**	**3.12**			**7,134**			**989**				**655**
	2	Aug. 16, 1892	14.4	0.758	60	3.68	3.67	13,690	13,000	1,860,000	4.15	7.9	10.56	8,420	3.72	14.50	1,103	0.715	11,690	3.97	§739
								13,306	**11,060**	**1,825,200**	**3.91**			**8,228**			**1,062**				**720**
	3	Aug. 21, 1891	25.3	0.602	140	7.93	3.67	14,200	9,650	2,400,000	2.58	7.9	12.66	7,380	3.40	14.42	929	0.427	17,800	4.00	947
								17,128	**11,790**	**2,588,600**	**3.65**			**9,300**			**1,328**				**1,204**
														8,860							
 Log 4.	1	July 20, 1891	20.4	0.728	60	3.50	3.73	10,800	7,490	1,550,000	2.34	8.1	12.80	6,050	3.71	13.67	720	0.828	19,320	4.08	611
								12,842	**8,900**	**1,671,400**	**3.13**			**7,252**			**969**				**763**
	1	Aug. 16, 1892	16.4	0.749	60	3.68	3.65	13,130	10,380	1,810,000	3.44	8.0	10.66	6,820	3.71	14.46	1,253	0.706	19,370	4.02	706
								13,818	**10,740**	**1,853,400**	**3.77**			**7,185**			**1,329**				**746**
	2	July 23, 1891	20.9	0.700	60	3.42	3.72	9,930	6,620	1,710,000	1.76	8.1	12.72	5,920	3.73	13.32	710	1.270	10,390	4.06	655
								12,087	**8,120**	**1,839,400**	**2.58**			**7,242**			**977**				**825**
	2	Aug. 16, 1892	13.9	0.764	60	3.50	3.43	12,590	10,000	1,540,000	3.97	8.1	11.94	†7,370	3.43	13.56	1,269	0.585	8,200	3.52	863
								11,876	**9,530**	**1,472,000**	**3.50**			**7,013**			**1,191**				**833**

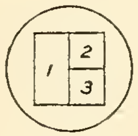
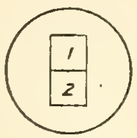
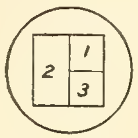
 Log 6.	1	Aug. 17, 1891	18.3	0.643	60	3.50	3.70	9,030 **10,476**	7,140 **8,100**	1,260,000 **1,345,400**	2.61 **3.21**	8.1	12.48	5,320 **6,120**	3.72	13.71	960 **1,125**	0.947	10,560	3.94	632 **726**
	2	July 23, 1891	24.4	0.741	60	3.52	3.74	9,480 **12,275**	6,220 **8,260**	1,390,000 **1,567,200**	1.85 **2.87**	8.1	13.17	5,180 **6,993**	3.52	14.70	1,070 **1,445**	1.133	12,360	4.14	738 **978**
 Log 7.	1	July 27, 1891	18.8	0.681	60	3.46	3.75	‡7,220 **8,826**	6,220 **7,290**	1,040,000 **1,134,400**	2.49 **3.14**	8.0	12.69	‡4,750 **5,650**	3.72	13.52	990 **1,176**	1.080	‡13,340	4.02	566 **673**
	2	Aug 17, 1891	17.7	0.621	60	3.51	3.72	7,070 **8,306**	5,500 **6,310**	1,070,000 **1,143,700**	1.81 **2.34**	8.1	13.10	4,950 **5,623**	3.72	13.83	1,070 **1,208**	0.936	12,390	4.14	664 **741**

* Wind-shaken. † Failed by shearing. ‡ Knot. § Broke in tension.

[Species: *Pinus palustris*. Habitat: Wallace, Ala.; upland forest, moderately dense woods. **TREE No. 2**; cut November, 1890; sawed February, 1891; age, 196 years.]

LOG DIAGRAM:



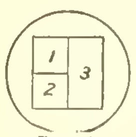
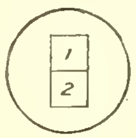
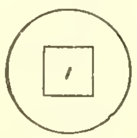
 Log 1.	1	Aug. 19, 1891	20.0	0.778	140	7.84	3.68	*12,100 **14,050**	10,690 **12,020**	2,400,000 **2,486,000**	3.23 **3.99**	38.0	13.76	5,620 **6,750**	3.78	14.58	750 **985**	1.041	13,830	4.03	822 **966**
												8.1	14.03	5,870 **7,000**							
	2	July 22, 1891	16.5	0.778	60	3.47	3.69	10,430 **11,165**	9,030 **9,520**	2,240,000 **2,265,800**	2.49 **2.84**	8.0	12.98	6,180 **6,570**	3.73	13.79	830 **911**	1.136	17,780	4.02	673 **716**
		Aug. 16, 1892	12.4	0.824	60	3.52	3.44	14,740 **12,928**	10,140 **8,210**	1,060,000 **1,850,280**	3.15 **2.00**	8.0	12.18	8,190 **7,218**	3.57	13.71	1,197 **968**	0.690	15,410	4.03	606 **533**
	3	July 17, 1891	21.3	0.730	60	3.54	3.72	10,290 **12,533**	7,720 **9,290**	1,570,000 **1,678,360**	2.37 **3.22**	8.0	13.24	5,830 **7,190**	3.71	13.99	810 **1,091**	0.940	19,370	4.06	468 **644**
		Aug. 17, 1892	12.3	0.782	60	3.30	3.33	14,720 **12,836**	12,160 **10,100**	1,990,000 **1,943,560**	4.64 **3.44**	8.1	10.89	8,360 **7,341**	3.28	13.20	1,144 **903**	0.772	11,590	3.68	570 **494**
 Log 2.	1	July 13, 1891	19.6	0.752	60	3.44	3.72	10,200 **12,038**	7,810 **8,410**	1,930,000 **2,009,120**	1.88 **2.61**	8.0	12.79	6,330 **7,384**	3.75	13.44	1,000 **1,219**	(†)	(†)	4.76	522 **652**
	2	July 13, 1891	17.7	0.712	60	3.42	3.73	10,730 **11,966**	7,430 **8,240**	1,740,000 **1,786,440**	1.97 **2.50**	7.9	12.45	5,810 **6,483**	3.74	13.00	780 **918**	0.904 0.731	12,840 14,500	4.64	514 **741**
 Log 3.	1	July 22, 1891	21.2	0.695	60	3.53	3.74	9,930 **12,152**	6,950 **8,500**	1,740,000 **1,846,640**	1.78 **2.62**	8.0	13.02	5,170 **6,513**	3.73	13.79	840 **1,118**	1.058	12,760	3.91	452 **625**
		Aug. 16, 1892	12.6	0.711	60	3.49	3.36	13,630 **11,962**	11,760 **10,090**	2,040,000 **1,998,720**	3.92 **2.87**	8.1	11.66	7,640 **6,762**	3.37	13.75	1,370 **1,165**	0.707	10,750	3.79	1,010 **942**
	2	Aug. 19, 1891	19.2	0.720	140	7.90	3.71	10,600 **12,326**	9,020 **10,180**	2,220,000 **2,292,240**	2.35 **3.04**	38.1	13.14	5,590 **6,568**	3.78	14.46	900 **1,103**	0.744	12,910	4.18	688 **808**
												7.9	13.87	6,480 **7,458**							
	3	July 25, 1891	18.2	0.676	60	3.58	3.74	9,270 **10,684**	7,470 **8,410**	1,390,000 **1,445,040**	2.56 **3.15**	8.0	13.10	5,650 **6,430**	3.72	13.76	950 **1,111**	0.946	8,030	3.97	748 **839**
		July 8, 1892	12.8	0.696	60	3.67	3.59	14,520 **12,996**	11,240 **9,830**	1,830,000 **1,792,160**	3.97 **3.00**	8.0	13.60	7,250 **6,466**	3.71	14.66	1,080 **899**	0.932	12,100	4.03	624 **671**

* Knot. † No record.

TABLE I.—CONDENSED RESULTS OF INDIVIDUAL TESTS ON LONG-LEAF YELLOW PINE—Continued.

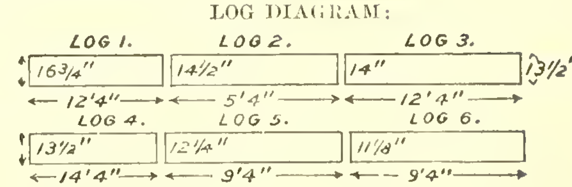
TREE No. 2—Continued.

[Reduced results at 15 per cent moisture given in bold-faced type.]

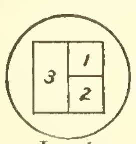
Log number and method of cutting.	No. of stick.	Date of test.	Per-centage of moisture.	Specific gravity.	Cross-bending tests. Dimensions. *l*.	*h*.	*b*.	Modulus of ultimate strength. $f=\frac{3}{2}\frac{W\,l}{b\,h^2}$	Modulus of strength at the elastic limit, per square inch. $f=\frac{3}{2}\frac{W_1\,l}{b\,h^2}$	Modulus of elasticity.	Relative elastic resilience in inch-pounds per cub. inch.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean)	Strength (mean) per square inch.
					In.	*In.*	*In.*	*Pounds.*				*In.*	*Sq. in.*	*Pounds.*	*In.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*
	1	July 20, 1891	20.0	0.682	60	3.49	3.75	9,020	5,710	1,350,000	1.64	8.2	13.12	4,930	3.76	13.83	850	0.965	10,150	4.10	571
								10,970	**7,040**	**1,436,000**	**2.40**			**6,060**			**1,085**				**714**
	1	Aug. 16, 1892	12.1	0.721	60	3.48	3.32	13,210	10,750	1,700,000	4.20	8.1	11.66	7,840	3.36	13.56	1,221	0.560	14,630	3.54	592
								11,182	**8,430**	**1,650,120**	**2.90**			**6,727**			**956**				**510**
	2	July 20, 1891	18.7	0.625	60	3.50	3.74	8,740	6,680	1,350,000	2.12	8.0	12.91	5,740	3.72	13.71	810	1.006	13,520	4.08	638
								10,311	**7,730**	**1,413,640**	**2.76**			**6,620**			**992**				**743**
	2	Aug. 16, 1892	12.6	0.687	60	3.48	3.38	11,520	9,790	1,380,000	3.46	8.1	11.69	7,340	3.45	13.24	1,031	0.521	14,980	3.75	809
								9,852	**8,120**	**1,338,720**	**2.41**			**6,462**			**826**				**732**
Log 4.	3	Aug. 19, 1891	18.1	0.662	164	7.74	3.74	8,570	8,570	1,840,000	2.27	38.0	13.50	*4,380	3.79	14.54	760	0.778	17,500	4.10	654
								9,952	**9,480**	**1,893,320**	**2.85**			**5,140**			**916**				**841**
												8.2	13.87	5,770							
														6,530							
	1	July 16, 1891	20.7	0.730	60	3.46	3.72	8,810	6,850	1,790,000	1.72	8.1	12.73	5,650	3.44	14.54	750	1.012	12,810	4.16	652
								10,921	**8,310**	**1,888,040**	**2.53**			**6,906**			**1,010**				**817**
	2	Aug. 17, 1891	17.1	0.644	60	3.51	3.74	8,400	6,100	1,100,000	2.07	8.1	13.02	4,980	3.73	13.75	920	1.012	6,330	3.95	504
Log 6.								**9,408**	**6,760**	**1,136,120**	**2.51**			**5,518**			**1,031**				**565**
	1	July 20, 1891	20.1	0.704	60	3.40	3.72	7,760	5,020	886,000	2.35	8.0	12.53	4,640	3.74	13.24	950	0.770	9,610	3.65	454
Log 7.								**9,733**	**6,370**	**973,720**	**3.12**			**5,788**			**1,189**				**600**

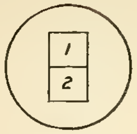
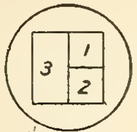
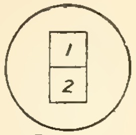
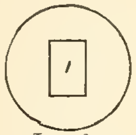
* Knot.

LOG DIAGRAM:



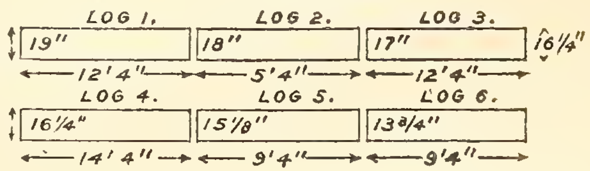
[Species: *Pinus palustris*. Habitat: Wallace, Ala.; upland forest; moderately dense woods. **TREE No. 3**: cut November, 1890; sawed February, 1891; age, 183 years.]

Log number and method of cutting.	No. of stick.	Date of test.	Per-centage of moisture.	Specific gravity.	*l*.	*h*.	*b*.	Modulus of ultimate strength.	Modulus of strength at the elastic limit.	Modulus of elasticity.	Relative elastic resilience.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean)	Strength (mean) per square inch.
	2	Aug. 14, 1891	17.4	0.703	60	3.48	3.72	9,890	7,990	2,060,000	1.82	8.1	12.88	6,520	3.51	14.54	789	0.790	31,890	3.82	556
								11,012	**8,720**	**2,162,960**	**2.32**			**7,125**			**904**				**623**
	2	Aug. 17, 1892	12.1	0.774	60	3.08	3.20	15,360	11,710	1,960,000	4.13	8.1	9.86	7,400	3.21	12.42	1,304	0.623	12,270	....	....
								13,332	**9,390**	**1,835,590**	**2.83**			**6,287**			**1,039**				
	3	July 15, 1891	20.3	0.687	144	7.97	3.72	12,610	10,600	2,890,000	2.42	8.0	14.74	6,500	3.79	14.65	810	1.040	22,500	4.13	514
Log 1.								**14,629**	**11,990**	**3,117,370**	**3.20**			**7,684**			**1,056**				**664**

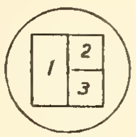
 Log 2.	1	July 10, 1891	20.0	0.713	60	3.41	3.74	10,740 12,690	8,480 9,810	2,290,000 2,504,500	2.01 2.77	8.0	13.02	6,230 7,360	3.72	13.67	800 1,035	0.625 0.654	22,250 14,520	4.25	530 672
	2	July 9, 1891	18.4	0.726	60	3.39	3.74	10,870 12,348	7,850 8,830	2,075,000 2,220,860	1.65 2.26	8.0	13.01	5,930 6,750	3.45	14.69	780 949	0.787	18,930	3.89	600 697
 Log 3.	1	July 20, 1891	16.8	0.617	60	3.50	3.72	10,230 11,106	8,260 8,830	1,760,000 1,837,220	2.28 2.68	8.1	12.87	6,040 6,505	3.73	13.63	760 856	0.976	11,680	4.06	600 651
		Aug. 17, 1892	13.9	0.626	60	3.20	3.20	11,400 10,686	9,750 9,280	1,570,000 1,522,810	3.39 2.92	8.1	9.99	7,590 7,233	3.12	12.54	886 808	0.660	13,180	3.64	625 595
	2	July 17, 1891	19.0	0.710	60	3.46	3.72	9,238 10,908	7,280 8,400	1,610,000 1,781,600	2.07 2.74	8.0	13.05	5,700 6,640	3.73	13.83	800 995	0.731	12,860	4.28	504 618
		Aug. 17, 1892	12.1	0.679	60	3.21	3.24	*13,480 11,452	10,780 8,460	1,810,000 1,685,590	4.02 2.72	8.1	10.27	†8,040 6,927	3.24	12.34	1,053 788	0.835	8,380	3.64	766 694
	3	July 9, 1891	21.8	0.665	144	7.93	3.72	‡12,280 14,628	7,390 9,050	2,690,000 2,981,720	1.24 2.32	8.3 35.0	13.76 13.65	5,720 7,162 4,870 5,312	3.75	14.58	880 1,177	1.062	19,300	4.88	666 854
 Log 4.	1	Aug. 14, 1891	14.8	0.581	60	3.50	3.74	9,120 8,929	7,860 7,780	1,750,000 1,741,420	2.83 2.75	8.1	13.28	5,910 5,846	3.71	14.03	970 956	0.632	15,990	3.85	640 634
		Aug. 17, 1892	12.1	0.650	60	3.04	3.16	13,310 11,282	11,150 8,830	1,820,000 1,695,590	4.41 3.11	8.1	9.70	†6,440 5,327	3.28	7.95	1,197 932	0.715	18,730	3.70	702 620
	2	July 20, 1891	16.0	0.613	60	3.44	3.73	8,750 9,250	7,750 8,090	1,560,000 1,602,900	2.34 2.59	7.5	13.05	5,400 5,665	3.72	13.79	900 956	0.911	9,660	4.19	533 562
		Aug. 17, 1892	13.0	0.693	60	3.27	3.22	11,500 10,120	9,410 8,260	1,390,000 1,304,200	3.77 2.88	8.1	10.46	§6,590 5,900	3.25	12.73	1,084 927	0.660	13,140	3.56	608 552
 Log 6.	1	July 25, 1891	18.4	0.578	60	3.54	3.70	†3,110 4,588	2,530 3,510	921,000 1,066,860	0.45 1.06	8.1	13.10	4,000 4,820	3.72	15.72	‖820 989	0.984	7,520	4.03	596 692

* Wind-shaken. † Knot. ‡ Season checked. Failed by shearing. § Very resinous. ‖ Hole at center.

LOG DIAGRAM:



[Species: *Pinus palustris*. Habitat: Wallace, Ala.; upland forest, moderately dense woods. **TREE No. 4**; cut November, 1890; sawed February, 1891; age, 189 years.]

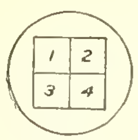
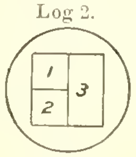
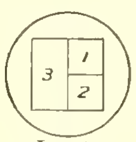
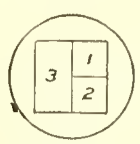
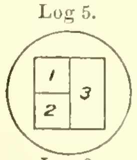
 Log 1.	1	July 9, 1891	22.0	0.688	144	8.00	3.75	12,830 15,220	10,800 12,490	2,600,000 2,745,000	2.83 3.72	8.0 35.0	13.99 13.62	5,900 7,375 5,180 6,655	3.79	14.62	660 964	0.559	27,910	4.46	581 773
	2	Aug. 18, 1891	17.3	0.735	60	3.38	3.71	*7,320 8,404	4,240 4,950	1,510,000 1,575,300	0.71 1.19	8.0	6.52	5,850 6,433	2.24	5.56	1,110 1,230	0.704	22,740	3.50	737 802
		July 8, 1892	13.1	0.828	60	3.66	3.64	17,440 16,134	12,360 11,190	2,060,000 1,912,000	4.83 3.99	8.0	9.80	9,400 8,747	3.69	14.34	1,320 1,172	0.781	22,000	4.10	712 660
	3	Aug. 17, 1891	16.6	0.698	60	3.50	3.72	11,450 12,232	7,110 7,620	1,660,000 1,708,600	1.74 2.11	8.1	12.58	6,210 6,625	3.42	14.73	830 916	0.954	11,010	4.02	677 823
		Aug. 15, 1892	12.8	0.828	60	3.19	3.19	11,490 9,966	11,360 9,950	1,820,000 1,634,800	4.91 3.94	6.8	10.24	8,970 8,186	3.23	12.58	1,475 1,294	0.675	10,280	3.47	810 748

* Knot.

TABLE I.—CONDENSED RESULTS OF INDIVIDUAL TESTS ON LONG-LEAF YELLOW PINE—Continued.

[Reduced results at 15 per cent moisture given in bold-faced type.]

[Species: *Pinus palustris*. Habitat: Wallace, Ala.; upland forest. **TREE No. 4**—Continued.

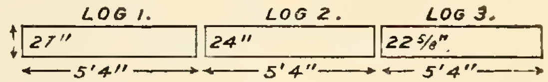
Log number and method of cutting.	No. of stick.	Date of test.	Per-cent-age of mois-ture.	Spe-cific grav-ity.	Cross-bending tests. Dimensions. *l.*	*h.*	*b.*	Modulus of ultimate strength. $f=\frac{3\ W\ l}{2\ b\ h^2}$	Modulus of strength at the elastic limit, per square inch. $f=\frac{3\ W_1\ l}{2\ b\ h^2}$	Modulus of elasticity.	Relative elastic resilience in inch-pounds per cub. inch.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean)	Strength (mean) per square inch.
					In.	*In.*	*In.*	*Pounds.*				*In.*	*Sq. in.*	*Pounds.*	*In.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*
 Log 2.	1	July 17, 1891	18.6	0.722	60	3.48	3.71	10,580 **12,122**	9,420 **10,450**	1,520,000 **1,600,800**	3.68 **4.21**	8.1	12.57	6,190 **7,050**	3.50	14.66	770 **948**	0.307	25,060	4.19	646 **748**
	2	July 23, 1891	17.8	0.642	47	2.92	3.72	10,020 **11,291**	7,550 **8,390**	1,430,000 **1,505,900**	2.47 **3.01**	8.1	10.82	6,580 **7,275**	3.74	11.36	920 **1,063**	......	......	......	......
	4	July 17, 1891	18.9	0.717	60	3.44	3.72	11,000 **12,638**	8,590 **9,690**	1,820,000 **1,916,200**	2.62 **3.28**	8.0	12.20	5,940 **6,860**	3.34	14.62	850 **1,041**	1.028	24,900	4.17	454 **565**
 Log 3.	1																				
	2	Aug. 17, 1891	15.7	0.627	60	3.52	3.72	9,350 **9,700**	7,420 **7,660**	1,660,000 **1,683,100**	2.01 **2.20**	8.1	13.10	6,280 **6,466**	3.73	13.95	880 **919**	1.058	17,190	4.16	746 **766**
		Aug. 17, 1892	11.8	0.661	60	3.14	3.08	13,130 **11,880**	10,670 **7,960**	1,870,000 **1,548,800**	3.57 **2.14**	8.1	9.36	7,810 **6,538**	3.00	12.22	1260 **954**	0.560	12,490	3.79	710 **619**
	3	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
 Log 4.	1	July 16, 1891	17.7	0.629	60	3.46	3.71	9,770 **11,006**	8,190 **9,000**	1,650,000 **1,723,700**	2.73 **3.26**	8.0	12.73	5,680 **6,353**	3.45	14.62	760 **898**	0.782	8,950	4.15	461 **539**
		Aug. 17, 1892	12.1	0.637	60	3.24	3.27	11,350 **9,322**	9,460 **7,140**	1,750,000 **1,469,600**	3.38 **2.08**	8.1	10.72	7,330 **6,217**	3.35	12.89	1,040 **775**	0.688	12,360	3.52	692 **610**
	2	Aug. 14, 1891	14.8	0.575	60	3.42	3.71	8,340 **8,212**	6,600 **6,520**	1,510,000 **1,498,400**	1.42 **1.34**	8.1	12.58	5,610 **5,546**	3.70	13.48	760 **746**	0.840	11,730	3.76	576 **570**
		Aug. 17, 1892	11.7	0.612	60	3.14	3.25	10,420 **8,095**	10,420 **7,580**	1,560,000 **1,225,200**	4.61 **3.14**	8.1	10.02	7,710 **6,382**	3.20	12.34	1,084 **764**	0.670	11,950	3.68	695 **602**
	3	July 15, 1891	20.7	0.652	144	7.98	3.73	10,910 **13,021**	9,820 **11,280**	1,930,000 **2,056,200**	3.12 **3.93**	8.0 39.0	14.66 14.73	5,990 **7,246** 4,540 **5,796**	3.93	14.62	730 **990**	0.778	17,090	4.24	538 **698**
 Log 5.	1	Aug. 14, 1891	14.9	0.647	60	3.45	3.45	*9,490 **9,126**	6,310 **6,270**	1,710,000 **1,704,200**	1.53 **1.49**	8.1	12.81	5,170 **5,138**	3.68	13.83	870 **863**	0.954	10,480	4.24	582 **579**
	2	Aug. 14, 1891	15.4	0.623	60	3.43	3.61	7,440 **7,640**	6,150 **6,290**	1,330,000 **1,343,200**	1.80 **1.92**	8.1	12.65	5,460 **5,566**	3.74	13.48	840 **862**	0.772	15,800	3.86	658 **670**
	3	Aug. 19, 1891	18.7	0.652	106	7.85	3.70	9,280 **10,854**	5,580 **6,630**	2,250,000 **2,342,600**	1.03 **1.67**	38.1 7.9	13.98 13.62	†4,150 **5,030** 5,350 **6,230**	3.62	14.62	1,000 **1,182**	0.803	12,700	3.94	569 **674**
 Log 6.	1	Aug. 17, 1891	16.0	0.600	60	3.44	3.75	9,150 **9,650**	7,470 **7,810**	1,560,000 **1,593,000**	2.31 **2.56**	8.0	12.71	5,650 **5,915**	3.75	13.40	985 **1,041**	0.821	18,100	3.80	610 **739**
	2	Aug. 18, 1891	17.3	0.609	34.5	2.40	2.41	7,680 **8,764**	5,670 **6,380**	956,000 **1,021,300**	2.21 **2.69**	8.1	13.84	5,450 **6,033**	3.71	14.54	956 **1,076**	0.744	16,940	4.14	670 **736**
	3	Aug. 19, 1891	18.3	0.607	106	7.85	3.70	6,510 **7,956**	4,530 **5,490**	1,710,000 **1,795,400**	0.91 **1.51**	38.0 7.9	13.35 13.95	5,010 **5,810** 4,770 **5,570**	3.74	14.70	820 **985**	0.900	9,560	4.08	416 **610**

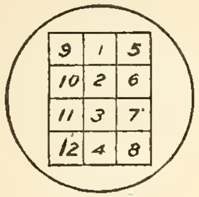
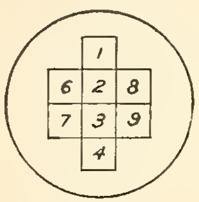
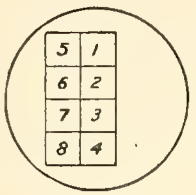
* Failed by shearing.

† Knot.

[Species: *Pinus palustris*. Habitat: Wallace, Ala.; upland forest. **TREE No. 5**; cut November, 1890; sawed February, 1891; age, 226 years.]

LOG DIAGRAM:



 Log 1.	1	July 9, 1891	26.2	0.766	60	3.13	3.71	11,340	8,770	1,990,000	2.32	8.0	11.10	6,120	3.01	14.50	1,030	0.719	20,860	4.87	666
								14,395	**11,010**	**2,189,400**	**3.43**			**8,142**			**1,451**				**937**
	3	July 10, 1891	21.0	0.807	60	3.48	3.62	11,760	9,030	2,120,000	1.16	8.0	12.70	6,080	3.71	13.52	910	0.865	21,150	4.34	809
								13,940	**10,550**	**2,251,000**	**1.99**			**7,390**			**1,181**	0.857	29,620		**877**
	4	July 13, 1891	19.8	0.827	60	3.03	3.75	10,690	8,360	1,970,000	2.22	8.0	11.67	5,290	3.72	12.06	1,200	1.100	15,360	4.58	462
								12,584	**9,650**	**2,081,600**	**2.97**			**6,382**			**1,427**	1.082	17,370		**598**
	5	July 11, 1891	19.4	0.822	60	3.50	3.73	10,160	6,890	2,230,000	2.04	8.0	12.83	5,560	3.72	13.56	960	0.655	24,600	4.88	621
								11,942	**8,090**	**2,334,800**	**2.75**			**6,576**			**1,171**	0.713	22,150		**746**
	7	July 10, 1891	19.4	0.780	60	3.47	3.75	10,200	6,670	2,140,000	1.40	8.0	12.57	6,470	3.76	13.40	810	0.577	31,170	3.61	728
								11,982	**7,870**	**2,244,800**	**2.11**			**7,486**			**1,021**	0.887	20,960		**853**
	8	July 10, 1891	22.8	0.807	60	3.45	3.76	9,170	6,640	1,610,000	1.71	8.0	13.12	*4,780	3.75	13.71	870	0.759	19,490	4.31	774
								11,708	**8,450**	**1,766,200**	**2.65**			**6,375**			**1,199**	0.825	13,700		**935**
	9	July 10, 1891	21.2	0.845	60	3.51	3.74	10,760	7,030	2,140,000	1.34	8.0	13.05	5,760	3.71	13.99	790	0.739	15,150	5.04	740
								12,982	**8,580**	**2,273,800**	**2.18**			**7,103**			**1,068**	0.735	19,880		**913**
	10	July 10, 1891	22.5	0.784	60	3.48	3.68	12,110	8,480	2,330,000	1.90	8.0	12.90	5,730	....	....	....	0.798	21,290	4.64	1,096
								14,593	**10,250**	**2,482,000**	**2.82**			**7,280**				0.836	23,930		**1,299**
	12	July 10, 1891	21.5	0.804	60	3.45	3.68	9,760	7,400	1,820,000	1.85	8.0	13.08	4,950	3.73	13.79	680	0.574	†10,100	3.94	796
								12,045	**9,010**	**1,958,000**	**2.71**			**6,343**			**968**	0.968	14,470		**975**
 Log 2.	1	July 9, 1891	20.7	0.743	60	3.44	3.61	9,800	6,740	2,241,000	1.27	8.1	12.18	5,160	3.45	13.95	930	0.893	19,940	4.33	753
								11,911	**8,200**	**2,377,200**	**2.08**			**6,416**			**1,190**				**913**
	2	July 13, 1891	19.8	0.822	60	3.41	3.70	11,040	8,110	2,320,000	1.66	8.0	12.82	6.490	3.75	13.40	950	0.634	29,950	4.42	608
								12,934	**9,400**	**2,431.600**	**2.41**			**7,582**			**1,177**	0.882	20,970		**744**
	3	July 11, 1891	20.8	0.769	60	3.48	3.75	11.460	8,720	2.220,000	2.15	8.1	12.94	6,190	....	....	....	1.096	18,800	4.75	692
								13,594	**10,200**	**2,347,800**	**2.97**			**7,464**				0.759	29,500		**852**
	4	July 11, 1891	20.2	0.730	60	3.40	3.73	9,430	7,090	1,730,000	1.75	8.0	12.53	5,300	3.72	13.28	1,200	0.891	14,590	5.34	496
								11,426	**8,460**	**1,848,200**	**2.52**			**6,466**			**1,442**				**644**
	6	July 13, 1891	21.4	0.753	60	3.28	3.72	13,130	8,990	2,300,000	2.21	8.0	12.64	5,510	3.73	13.16	770	0.984	12,600	(4.52)	780
								15,394	**10,580**	**2,436,600**	**3.06**			**6,886**			**1,054**				**957**
	7	July 9, 1891	18.6	0.768	60	3.47	3.72	11,680	8,240	2,190,000	1.65	8.0	13.06	5,530	3.75	14.07	870	0.938	17,260	4.22	666
								13,222	**9.270**	**2,280,800**	**2.28**			**6.390**			**1,048**				**768**
	9	July 7, 1891	19.7	0.746	60	3.74	3.73	10,260	6,900	2,210,000	2.10	8.0	13.83	6,250	3.73	14.66	850	0.650	15,690	4.21	526
								12,126	**8,170**	**2,319,900**	**2.84**			**7,323**			**1,073**				**659**
 Log 3.	1	July 13, 1891	20.9	0.721	60	3.27	3.73	10,580	7,220	1,950,000	1.76	8.1	12.38	5,510	3.74	13.32	1,160	0.772	20,730	5.01	568
								12,714	**8,720**	**2,079,400**	**2.58**			**6.802**			**1,427**	0.866	19,750		**733**
	2	July 11, 1891	19.1	0.767	60	3.05	3.73	11,780	7,780	2,300,000	1.66	8.0	10.65	5,800	3.73	11.08	850	0.804	17,150	3.48	604
								13,478	**8,920**	**2,399,700**	**2.34**			**6,759**			**1,049**	0.961	15,600		**721**
	3	July 11, 1891	19.6	0.748	60	3.40	3.78	12,360	9,060	2,250,000	2.36	8.0	12.57	6,170	3.72	13.36	840	0.806	22,340	4.70	809
								14,198	**10,310**	**2,358,200**	**3.09**			**7,224**			**1,059**	0.730	23,280		**940**
	4	July 11, 1891	23.3	0.694	60	3.45	3.72	9,070	6,710	1,630,000	1.72	8.0	12.72	4,909	3.72	13.40	720	0.918	18,530	4.69	690
								11,693	**8,600**	**1,792,900**	**2.69**			**6,567**			**1,064**	0.703	11,090		**910**
	5	July 13, 1891	18.8	0.682	60	3.41	3.73	10,700	7,670	1,900,000	1.99	8.0	12.39	5,820	3.71	13.63	890	0.484	16,340	4.96	622
								12,306	**8,740**	**1,994.400**	**2.64**			**6.720**			**1,076**	0.824	20,630		**729**
	6	July 8, 1891	19.8	0.746	60	3.71	3.71	10,570	8,460	2,280,000	1.91	8.1	13.88	6,380	3.71	14.58	790	0.857	18,320	4.82	588
								12,464	**9,750**	**2,391,600**	**2.66**			**7,472**			**1,017**				**773**
	7	July 11, 1891	18.8	0.758	60	3.40	3.73	11,270	8,790	2,280,000	1.76	7.7	12.53	5,710	3.75	13.04	740	0.618	22,350	4.74	504
								12,876	**9,860**	**2,374,400**	**2.41**			**6,610**			**926**	0.942	18,690		**612**
	8	July 11, 1891	19.3	0.595	60	3.42	3.73	8,830	6,350	1,630,000	1.54	8.0	12.50	4,620	3.68	13.24	800	0.694	16,000	4.54	486
								10,584	**7,530**	**1,733,100**	**2.24**			**5,617**			**1,007**	0.778	14,270		**608**

* Very resinous.

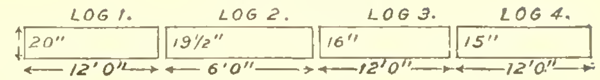
† Failed by shearing.

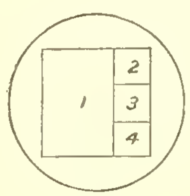
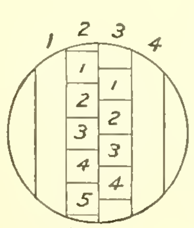
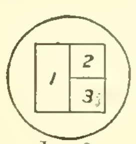
TABLE I.—CONDENSED RESULTS OF INDIVIDUAL TESTS ON LONG LEAF YELLOW PINE—Continued.

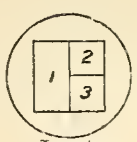
[Reduced results at 15 per cent moisture given in bold-faced type.]

[Species: *Pinus palustris*. Habitat: Thomasville, Ala.; poor, hilly land. **TREE No. 16**; cut April, 1891; sawed June, 1891; age, 202 years.]

LOG DIAGRAM:



Log number and method of cutting.	No. of stick.	Date of test.	Per-cent-age of mois-ture.	Spe-cific grav-ity.	Cross-bending tests. Dimensions. *l.*	*h.*	*b.*	Modulus of ulti-mate strength. $f=\frac{3\ W\ l}{2\ b\ h^2}$	Modulus of strength at the elastic limit, per square inch. $f=\frac{3\ W_1\ l}{2\ b\ h^2}$	Modulus of elasticity.	Rela-tive elastic resili-ence in inch-pounds per cub. inch.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean)	Strength (mean) per square inch.
					In.	*In.*	*In.*	*Pounds.*				*In.*	*Sq. in.*	*Pounds.*	*In.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*
 Log 1.	1	Aug. 11, 1891	24.6	0.828	136	11.85	5.90	*7,090 **9,915**	6,650 **8,710**	2,050,000 **2,105,680**	1.35 **2.38**	......	......	......	......	......	......	......	......	......	......
	2	Aug. 25, 1891	18.4	0.742	60	3.52	3.57	11,270 **12,748**	7,320 **8,300**	1,870,000 **1,889,720**	1.84 **2.45**	8.1	12.88	6,370 **7,190**	3.61	13.79	1,010 **1,102**	0.694	20,740	3.85	977 **1,009**
	2	July 14, 1892	11.5	0.818	60	3.44	3.53	16,290 **13,815**	11,200 **8,100**	2,200,000 **2,179,700**	2.44 **0.88**	8.0	12.11	8,260 **6,820**	3.51	13.40	1,094 **1,000**	0.680	18,650	4.12	758 **726**
	3	Aug. 27, 1891	17.6	0.794	60	3.52	3.63	12,000 **13,198**	9,440 **10,230**	1,890,000 **1,905,080**	3.02 **3.54**	8.0	12.38	6,910 **7,560**	3.57	13.67	1,530 **1,600**	0.664	25,000	3.86	840 **864**
	3	July 15, 1892	11.9	0.823	28	3.54	3.49	14,280 **12,105**	9,226 **6,640**	1,530,000 **1,512,020**	3.57 **2.18**	8.0	10.59	9,530 **8,314**	3.52	13.76	1,378 **1,294**	0.637	16,110	4.12	538 **509**
	4	Aug. 25, 1891	18.6	0.694	60	3.54	3.64	10,650 **12,192**	8,050 **9,080**	1,610,000 **1,630,880**	2.67 **3.30**	8.1	13.18	6,280 **7,140**	3.66	14.11	1,050 **1,147**	0.539	17,810	3.58	636 **668**
	4	July 11, 1892	11.6	0.718	60	3.53	3.49	12,300 **9,900**	9,940 **6,970**	1,830,000 **1,810,280**	3.49 **1.98**	7.7	12.25	8,147 **6,763**	3.51	13.30	1,350 **1,258**	0.772	15,450	3.92	1,012 **980**
1 2 3 4  Log 2.	2, 1	July 29, 1891	36.6	0.822	60	2.62	2.89	7,440 **11,622**	5,170 **8,290**	1,920,000 **2,015,280**	0.90 **2.35**	6.1	7.64	5,300 **8,262**	2.65	11.28	510 **1,093**	0.959	14,380	3.90	420 **618**
	2, 2	July 27, 1891	25.4	0.859	60	2.78	2.92	10,850 **13,792**	8,780 **10,930**	2,150,000 **2,210,320**	2.29 **3.36**	6.0	7.58	6,090 **8,021**	2.88	10.65	1,040 **1,321**	1.004	†21,900	4.02	587 **683**
	2, 3	July 28, 1891	24.7	0.811	60	2.67	2.85	(†)	....	....	......	6.1	7.25	5,600 **7,449**	2.84	10.22	700 **962**	0.975	14,760	3.96	534 **623**
	2, 4	July 29, 1891	24.6	0.812	60	2.72	2.99	5,590 **8,415**	4,390 **6,450**	1,300,000 **1,355,680**	0.85 **1.88**	6.0	8.23	5,660 **7,497**	2.95	11.12	789 **1,039**	1.062	8,760	4.00	†646 **735**
	2, 5	July 29, 1891	23.4	0.738	60	2.69	2.92	‡6,220 **8,859**	5,880 **7,790**	1,570,000 **1,618,720**	1.35 **2.32**	6.0	7.77	5,700 **7,381**	2.84	10.61	1,169 **1,396**	0.931	21,800	3.99	570 **648**
	3, 1	July 28, 1891	23.3	0.723	60	2.70	2.69	9,590 **12,213**	7,200 **9,090**	2,040,000 **2,088,140**	1.64 **2.61**	6.0	7.34	5,120 **6,787**	2.72	10.61	570 **794**	0.920	21,860	4.18	674 **751**
	3, 2	July 29, 1891	24.1	0.834	60	2.71	2.62	8,660 **11,410**	8,100 **10,100**	2,070,000 **2,122,780**	1.93 **2.94**	6.0	7.18	6,390 **8,167**	2.69	10.49	840 **1,086**	0.899	17,350	4.12	688 **772**
	3, 3	July 29, 1891	23.4	0.787	60	2.72	2.60	8,930 **11,569**	6,540 **8,450**	1,600,000 **1,648,720**	1.84 **2.81**	6.0	7.26	5,870 **7,551**	2.73	10.45	1,110 **1,337**	1.017	14,950	3.91	648 **726**
	3, 4	July 29, 1891	23.6	0.619	60	2.89	2.68	8,120 **10,791**	6,830 **8,760**	1,500,000 **1,549,880**	2.15 **3.13**	6.1	7.86	4,650 **6,359**	2.89	10.65	510 **742**	1.066	17,440	4.15	735 **815**
 Log 3.	1	Aug 27, 1891	16.4	0.768	140	8.04	4.02	10,910 **11,598**	8,080 **8,540**	2,070,000 **2,078,120**	1.91 **2.24**	7.2 38.1	15.01 14.94	5,820 **6,185** 5,230 **5,595**	3.93	15.09	1,050 **1,088**	0.836	15,780	3.76	820 **833**
	2	Sept. 2, 1891	23.9	0.767	60	3.52	3.69	9,940 **12,659**	7,640 **9,620**	1,910,000 **1,961,620**	1.87 **2.87**	7.8	12.88	5,260 **7,011**	3.66	13.83	740 **980**	0.735	17,960	3.81	712 **794**
	2	July 12, 1892	13.9	0.707	60	3.48	3.33	9,270 **8,556**	8,030 **7,560**	1,620,000 **1,613,620**	2.68 **2.21**	8.0	12.08	8,060 **7,703**	3.48	13.50	1,060 **1,036**	0.699	10,410	3.80	740 **730**
	3	Aug. 28, 1891	26.2	0.749	60	3.59	3.68	8,060 **11,015**	6,220 **8,460**	1,520,000 **1,584,960**	1.65 **2.76**	8.1	12.83	‡4,910 **6,932**	3.70	13.56	740 **1,012**	0.722	26,600	3.80	780 **883**
	3	July 11, 1892	11.9	0.674	60	3.58	3.48	14,730 **12,555**	10,650 **8,070**	1,860,000 **1,812,020**	4.03 **2.64**	7.4	12.25	8,134 **6,918**	3.51	13.60	1,080 **995**	0.648	14,200	4.00	748 **720**

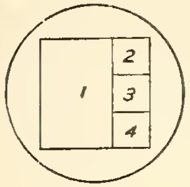
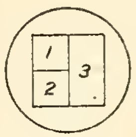
 Log 4.	1	Aug. 27, 1891	20.2	0.760	140	8.03	4.05	8,040 **10,036**	7,640 **9,010**	1,880,000 **1,910,160**	1.90 **2.67**	7.8	13.57	6,070 **7,236**	3.77	13.95	950 **1,090**	0.708	22,040	3.68	695 **742**
												38.1	14.82	4,750 **5,916**							
	2	Aug. 22, 1891	18.0	0.742	60	3.50	3.68	11,980 **13,330**	8,790 **9,680**	2,050,000 **2,067,400**	2.49 **3.05**	8.2	12.76	6,560 **7,300**	3.67	13.68	914 **995**	0.822	21,180	3.99	722 **750**
		July 11, 1892	13.4	0.707	60	3.49	3.52	14,570 **13,486**	11,340 **10,490**	1,880,000 **1,870,720**	4.23 **3.54**	7.9	12.04	8,260 **7,718**	3.49	13.60	1,100 **1,057**	0.630	†19,050	3.99	915 **901**
	3	Aug. 31, 1891	21.9	0.700	60	3.58	3.55	9,890 **12,259**	7,520 **9,190**	1,690,000 **1,730,020**	2.10 **2.98**	8.0	12.60	5,430 **6,889**	3.56	13.87	940 **1,126**	0.790	18,850	3.91	700 **763**
		July 7, 1892	11.8	0.673	60	3.48	3.51	§10,160 **7,910**	9,480 **6,770**	1,750,000 **1,731,440**	3.34 **1.91**	8.0	12.30	8,030 **6,758**	......	......	......	0.700	6,710	3.96	701 **671**

* Failed by shearing. † Cross-grained. ‡ Broke in grips. § Knot.

[Species: *Pinus palustris*. Habitat. Thomasville. Ala.; poor hilly land. **TREE No. 17**; cut April, 1891; sawed June, 1891; age, 163 years.]

LOG DIAGRAM:

LOG 1.	LOG 2.	LOG 3.
20"	17½"	16"
12'0"	6'0"	12'0"

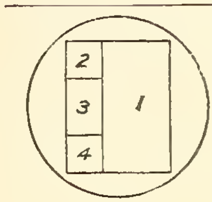
 Log. 1.	1	Aug. 14, 1891	22.8	0.804	132	11.9	5.9	†§5,780 **8,318**	6,820 **8,630**	1,620,000 **1,665,240**	*2.61 **3.55**	......	......	......	......	......	......	......	......	......	......
	2	Aug. 29, 1891	23.5	0.822	60	3.50	3.66	9,710 **12,365**	6,820 **8,740**	1,930,000 **1,979,300**	1.56 **2.54**	8.1	12.66	5,840 **7,535**	3.48	14.30	1,060 **1,149**	0.714	10,360	4.00	745 **824**
		July 11, 1892	12.2	0.748	60	3.51	3.49	‡10,700 **8,744**	9,210 **7,020**	1,970,000 **1,953,760**	2.72 **1.47**	7.9	12.28	7,898 **6,832**	3.51	13.60	1,010 **980**	0.706	17,630	4.04	886 **860**
	3	Sept. 1, 1891	21.3	0.759	60	3.54	3.60	10,650 **12,893**	7,990 **9,560**	2,150,000 **2,186,540**	1.99 **2.84**	7.9	12.71	5,480 **6,840**	3.52	14.18	980 **1,046**	0.800	21,120	3.95	708 **765**
		July 11, 1892	13.3	0.783	60	3.51	3.50	§5,920 **4,762**	5,850 **4,930**	2,070,000 **2,060,140**	0.97 **0.23**	7.6	12.36	5,360 **4,781**	3.48	13.70	1,080 **1,062**	0.772	12,500	4.02	916 **901**
	4	Sept. 2, 1891	35.4	0.680	60	3.48	3.68	7,610 **11,678**	5,690 **8,730**	1,440,000 **1,558,320**	1.43 **2.86**	7.9	12.32	5,200 **8,075**	3.64	13.79	700 **914**	0.766	12,040	3.30	744 **932**
		July 12, 1892	13.1	0.727	60	3.47	3.52	12,070 **10,764**	9,690 **8,620**	1,910,000 **1,898,980**	3.06 **2.22**	8.0	12.22	6,690 **6,037**	3.48	13.80	1,010 **990**	0.653	14,740	3.96	811 **794**
 Log. 3.	1	Aug. 26, 1891	21.1	0.723	60	3.60	3.64	8,320 **10,521**	6,870 **8,410**	1,810,000 **1,845,380**	1.77 **2.61**	8.1	13.07	5,530 **6,857**	3.65	14.06	990 **1,054**	0.741	16,870	3.93	784 **845**
		July 7, 1892	12.3	0.732	60	3.48	3.50	11,880 **9,996**	10,530 **8,470**	1,830,000 **1,814,340**	3.58 **2.38**	8.0	12.22	8,120 **7,101**	3.48	13.40	1,190 **1,161**	0.703	15,080	3.96	898 **873**
	2	Aug. 28, 1891	22.8	0.730	60	3.54	3.66	7,530 **10,068**	5,490 **7,300**	1,400,000 **1,445,240**	1.56 **2.50**	8.1	12.96	*4,620 **6,215**	3.56	14.30	780 **862**	0.784	8,940	3.82	685 **757**
		July 9, 1892	12.9	0.656	60	3.40	3.42	10,350 **8,898**	9,740 **8,460**	1,450,000 **1,437,820**	4.50 **3.57**	8.0	11.20	6,110 **5,373**	3.40	12.50	960 **938**	0.753	12,360	3.82	678 **659**
	3	Sept. 5, 1891	21.0	0.710	140	7.81	4.02	9,420 **11,600**	9,080 **10,600**	2,540,000 **2,574,800**	2.31 **3.14**	38.4	13.62	5,180 **6,490**	3.85	14.78	810 **873**	0.938	12,790	4.15	712 **767**
												7.9	13.40	5,160 **6,470**	......	......	......	......	......	......	......

* Season checked. † Failed by shearing. ‡ Knot. § Cross grained.

[Species: *Pinus palustris*. Habitat: Thomasville. Ala.; poor hilly land. **TREE No. 18**; cut April. 1891; sawed June, 1891; age, 210 years.]

LOG DIAGRAM:

LOG 1.	LOG 2.	LOG 3.
21½"	21½"	20"
12'0"	12'0"	6'0"

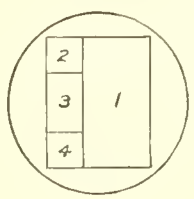
 Log 1.	1	Oct. 6, 1891	2.15	0.673	140	13.94	6.92	*6,910 **9,195**	6,620 **8,235**	1,760,000 **1,871,800**	1.55 **2.41**	......	......	......	......	......	......	......	......	......	......
	2	Aug. 22, 1891	2.09	0.719	60	3.58	3.59	9,370 **11,527**	6,650 **8,150**	1,700,000 **1,871,480**	1.67 **2.49**	8.0	13.06	5,530 **6,822**	3.67	13.99	550 **709**	0.713	19,630	3.66	810 **828**
		July 9, 1892	11.9	0.832	60	3.37	3.27	12,860 **10,685**	10,180 **7,600**	1,900,000 **1,846,680**	3.55 **2.16**	8.0	11.15	8,130 **6,914**	3.33	13.10	1,180 **1,096**	0.749	8,600	3.92	846 **836**
	3	Sept. 4, 1891	18.5	0.675	116	5.97	4.00	11,350 **12,860**	11,350 **12,350**	2,290,000 **2,350,200**	3.76 **4.38**	7.8	11.49	6,250 **7,090**	3.40	13.48	620 **716**	0.607	9,720	......	......
	4	Aug. 22, 1891	21.2	0.652	60	3.56	3.43	8,860 **11,082**	6,290 **7,840**	1,680,000 **1,786,640**	1.67 **2.51**	8.1	12.11	5,710 **7,053**	3.56	13.48	594 **761**	0.847	13,700	3.92	798 **817**

* Failed by shearing.

TABLE I.—Condensed Results of Individual Tests on Long-leaf Yellow Pine—Continued.

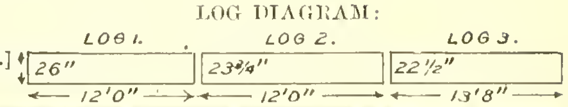
[Reduced results at 15 per cent moisture given in bold-faced type.]

TREE No. 18—Continued.

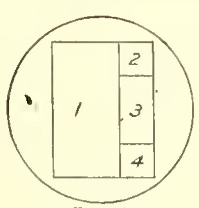
Log number and method of cutting.	No. of stick.	Date of test.	Per centage of moisture.	Specific gravity.	Cross-bending tests. Dimensions. l.	h.	b.	Modulus of ultimate strength. $f=\frac{3}{2}\frac{W\,l}{b\,h^2}$	Modulus of strength at the elastic limit, per square inch. $f=\frac{3}{2}\frac{W_1\,l}{b\,h^2}$	Modulus of elasticity.	Relative elastic resilience in inch-pounds per cub. inch.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean)	Strength (mean) per square inch.
					In.	*In.*	*In.*	*Pounds.*				*In.*	*sq. in.*	*Pounds.*	*In.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*
	1	Sept. 29, 1891	20.9	0.664	140	13.90	7.00	*7,640 **9,797**	7,640 **9,140**	1,790,000 **1,891,480**	2.27 **3.09**	......	......	......	......	......	......	......	......	......	......
	2	Sept. 1, 1891	22.1	0.648	60	3.57	3.63	8,290 **10,699**	6,230 **7,940**	1,570,000 **1,692,120**	1.53 **2.43**	7.9	12.60	5,190 **6,680**	3.60	13.79	680 **872**	0.700	19,570	3.80	522 **543**
	2	July 11, 1892	14.1	0.687	60	3.48	3.50	13,000 **12,424**	9,340 **8,980**	1,790,000 **1,774,520**	3.15 **2.77**	5.9	8.12	7,640 **7,352**	3.48	13.70	720 **696**	0.678	10,260 8,900	4.14	611 **608**
	3	Aug. 24, 1891	17.7	0.671	140	5.95	3.90	6,540 **7,776**	5,400 **6,210**	2,170,000 **2,216,440**	0.90 **1.43**	37.9 7.9	11.85 11.61	4,890 **5,563** 5,330 **6,003**	3.38	13.79	890 **963**	0.752	......	3.58	670 **678**
Log 2.	4	Aug. 24, 1891	18.9	0.690	60	3.46	3.62	9,640 **11,278**	6,980 **8,080**	1,440,000 **1,507,080**	2.21 **2.87**	8.1	12.71	5,640 **6,560**	3.60	13.83	880 **985**	0.775	8,000	4.02	647 **659**
	4	July 15, 1892	11.6	0.671	60	3.48	3.32	11,090 **8,690**	6,510 **5,540**	1,540,000 **1,481,520**	2.90 **1.39**	8.0	12.22	7,540 **8,924**	3.49	13.80	805 **713**	0.796	7,030	3.54	674 **664**

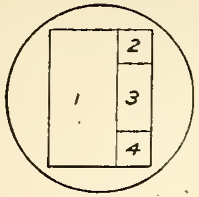
* Failed by shearing.

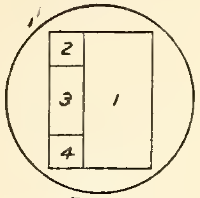
LOG DIAGRAM:



[Species: *Pinus palustris*. Habitat: Thomasville, Ala.; poor hilly land. **TREE No. 19**; cut April, 1891; sawed June, 1891; age, 160 years.]

Log number and method of cutting.	No. of stick.	Date of test.	Per centage of moisture.	Specific gravity.	l.	h.	b.	Modulus of ultimate strength.	Modulus of strength at the elastic limit.	Modulus of elasticity.	Relative elastic resilience.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean)	Strength (mean) per square inch.
	1	Oct. 1, 1891	30.0	0.809	1.36	15.96	8.02	*6,330 **9,855**	......	11,700,000 **1,945,000**	......	......	......	......	......	......	......	......	......	......	......
	2	Aug. 24, 1891	34.2	0.734	.60	3.52	3.58	9,920 **13,874**	6,900 **9,850**	1,800,000 **2,088,000**	1.66 **3.06**	8.1	12.21	5,090 **7,871**	3.57	13.60	540 **741**	0.818	16,980	4.14	778 **1,155**
	2	July 9, 1892	12.7	0.675	.60	3.49	3.54	13,670 **12,074**	10,020 **8,480**	2,220,000 **2,021,200**	3.10 **2.09**	8.0	12.20	7,220 **6,389**	3.49	13.80	770 **746**	0.699	19,300	3.98	1,089 **1,024**
	3	Aug. 27, 1891	20.1	0.832	1.40	7.81	3.83	12,670 **14,643**	10,150 **11,500**	2,370,000 **2,486,600**	2.76 **3.53**	6.1 38.1	7.84 13.80	6,390 **7,538** 5,280 **6,428**	2.85	11.79	4,290 **1,343**	0.728	20,470	3.49	825 **970**
Log 1.	4	Aug. 25, 1891	23.9	0.726	.60	3.68	3.50	10,370 **13,089**	7,140 **9,120**	1,860,000 **2,030,700**	1.75 **2.75**	8.0	12.14	5,630 **7,381**	3.69	13.79	720 **813**	0.617	26,400	4.00	860 **1,092**
	4	July 14, 1892	13.1	0.657	.60	3.50	3.53	13,500 **12,194**	10,430 **9,360**	1,860,000 **1,712,000**	3.56 **2.72**	8.0	12.32	7,220 **6,567**	3.51	13.76	907 **887**	0.653	18,160	4.05	760 **707**

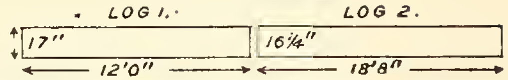

Log 2.


Log 3.

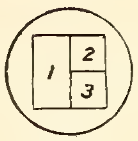
1	Oct. 1, 1891	25.0	0.724	1.34	15.94	8.25	7,880 **10,765**	6,230 **8,340**	1,850,000 **2,035,000**	1.46	....	....	....	....	....	....	....	....	....	....
2	Sept. 1, 1891	30.8	0.747	.60	3.53	3.61	7,680 **11,293**	6,030 **8,710**	1,990,000 **2,244,000**	1.14 **2.43**	7.8	12.15	4,830 **7,322**	3.53	13.87	490 **656**	0.710	17,030	4.10	612 **952**
	July 7, 1892	13.4	0.713	.60	3.51	3.47	15,620 **14,536**	12,400 **11,550**	2,160,000 **2,042,000**	4.84 **4.15**	8.0	12.14	7,440 **6,898**	3.42	13.80	835 **818**	0.703	13,950	4.02	1,078 **1,033**
3	Aug. 31, 1891	20.2	9.780	1.38	8.06	3.81	12,040 **14,036**	10.030 **11,400**	2,240,000 **2,358,200**	2.77 **3.54**	7.9 37.6	13.10 14.00	4,830 **5,996** 4,430 **5,596**	3.71	13.91	630 **684**	0.803	14,690	4.02	724 **871**
4	Sept. 2, 1891	26.3	0.729	.60	3.50	3.62	9,270 **12,338**	6,490 **8,740**	1,530,000 **1,730,600**	1.80 **2.92**	8.0	12.78	‡4,850 **6,883**	3.64	13.79	940 **1,058**	0.769	15,350	3.74	485 **759**
	July 18, 1892	12.7	0.688	.60	3.45	3.50	13,320 **11,724**	9,940 **8,400**	1,880,000 **1,681,200**	3.01 **2.00**	8.0	11.62	8,120 **7,289**	3.48	12.89	869 **845**	0.628	§24,900	3.95	794 **1,230**
1	Sept. 30, 1891	25.0	0.722	1.40	14.0	7.06	7,970 **10,855**	6,670 **8,780**	1,840,000 **2,025,000**	1.62 **2.67**	....	....	....	....	....	....	....	....	....	....
2	Aug. 29, 1891	22.2	0.703	.60	3.48	3.59	9,270 **11,697**	6,370 **8,090**	1,590,000 **1,737,800**	1.52 **2.42**	8.2	12.77	5,420 **6,925**	3.70	13.52	710 **785**	0.778	16,200	4.13	835 **1,031**
	July 11, 1892	14.1	0.644	.60	3.52	3.50	11,600 **11,024**	8,590 **8,230**	1,560,900 **1,507,800**	2.99 **2.61**	....	....	....	3.51	13.60	720 **710**	9.725	11,630	3.86	796 **770**
3	Sept. 4, 1891	20.7	0.752	1.16	6.05	3.99	11,320 **13,454**	8,340 **9,800**	2,300,000 **2,426,200**	2.25 **3.06**	7.8 38.1	11.73 12.69	5,150 **6,406** 4,840 **6,096**	3.31	13.64	910 **970**	0.850	14,820	....	....
4	July 21, 1891	25.9	0.658	.60	3.40	3.92	7,650 **10,664**	5,170 **7,380**	1,680,000 **1,875,800**	1.06 **2.16**	7.9	13.33	4,550 **6,539**	3.92	13.32	470 **584**	0.942	20,000	3.86	532 **799**
	July 7, 1892	15.1	0.681	.60	3.46	3.48	13,500 **13,550**	10,580 **10,610**	1,950,000 **1,953,300**	3.78 **3.81**	7.9	12.20	7,220 **7,247**	3.49	13.68	815 **816**	0.775	16,300	3.84	851 **854**

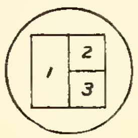
* Failed by shearing. † Sheared. ‡ Knot. § Broken grips.

LOG DIAGRAM:



[Species: *Pinus palustris*. Habitat: Thomasville, Ala.; poor hilly land. **TREE No. 20**; cut April, 1891; sawed June, 1891; age, 110 years.]


Log 1.


Log 2.

1	Aug. 22, 1891	19.6	0.801	140	7.89	3.85	12,260 **14,098**	8,410 **9,660**	2,900,000 **3,097,340**	1.73 **2.46**	7.9 38.0	13.50 12.84	6,960 **8,014** 5,640 **6,694**	3.77	14.15	1,039 **1,258**	0.847	13,350	4.01	1,067 **1,198**
2	Aug. 28, 1891	25.4	0.843	60	3.51	3.63	12,070 **15,012**	8,530 **10,680**	2,340,000 **3,097,340**	2.12 **3.19**	8.0	12.38	6,520 **8,451**	3.61	13.67	820 **1,221**	0.756	17,200	3.71	*680 **939**
	July 15, 1892	12.8	0.751	60	3.24	3.33	14,790 **13,266**	11,840 **10,430**	2,150,000 **2,055,620**	3.58 **2.61**	8.0	10.82	†8,650 **7,866**	3.32	12.69	1,323 **1,154**	0.598	16,930	3.70	970 **908**
3	Sept. 2, 1891	22.9	0.802	60	3.50	3.60	12,200 **14,757**	8,950 **10,780**	2,350,000 **2,688,910**	2.20 **3.14**	7.9	12.78	6,060 **7,670**	3.60	14.03	800 **1,132**	0.590	29,640	3.80	698 **911**
	July 12, 1892	15.1	0.732	60	3.53	3.50	14,220 **14,270**	10,320 **10,330**	1,820,000 **1,824,290**	3.74 **3.77**	8.0	12.32	6,840 **6,867**	3.51	13.70	1,160 **1,166**	0.650	27,400	4.08	972 **975**
1	Sept. 7, 1891	21.4	0.748	140	7.82	3.98	13,290 **15,554**	10,360 **11,950**	2,380,000 **2,697,460**	2.54 **3.39**	37.9 7.9	13.65 13.02	†5,540 **6,916** 6,740 **8,116**	3.80	13.71	980 **1,264**	0.868 0.822	17,740 12,900	3.80 4.54	782 **959** 682 **859**
2	Aug. 21, 1891	23.0	0.746	60	3.46	3.47	8,840 **11,415**	6,590 **8,440**	1,950,000 **2,293,200**	1.44 **2.39**	8.2	12.39	4,370 **5,995**	3.47	13.91	550 **885**	0.735	22,050	3.82	928 **1,141**
	July 14, 1892	17.9	0.761	60	3.50	3.52	1,020 **11,332**	8,770 **9,630**	1,680,000 **1,804,410**	2.77 **3.32**	8.0	12.28	7,680 **8,398**	3.50	13.68	988 **1,135**	0.602	16,600	3.83	750 **832**
3	Aug. 19, 1891	22.3	0.756	60	3.45	3.50	11,710 **14,156**	8,430 **10,170**	1,880,000 **2,193,170**	2.33 **3.24**	8.1	11.73	5,820 **7,340**	3.48	13.48	1,100 **1,413**	0.787	18,040	3.98	836 **1,036**
	July 20, 1892	19.1	0.870	60	3.36	3.49	12,420 **14,118**	10,280 **11,420**	1,630,000 **1,805,890**	3.97 **4.65**	8.0	11.30	7,640 **8,599**	3.38	13.72	1,260 **1,459**	0.725	13,600	3.82	920 **1,037**

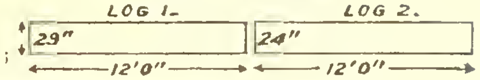
*Season-checked. †Knot.

TABLE I.—Condensed Results of Individual Tests on Long-leaf Yellow Pine—Continued.

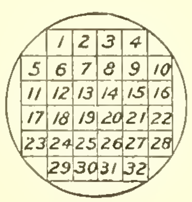
[Reduced results at 15 per cent moisture given in bold-faced type.]

[Species: *Pinus palustris*. Habitat: Wilson; Ala.; good pine land; well sheltered. **TREE No. 52**; cut October, 1891; sawed November, 1891; age –, years.]

LOG DIAGRAM:

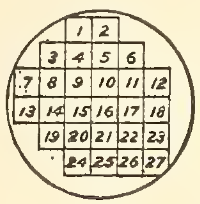


Log number and method of cutting.	No. of stick.	Date of test.	Per-cent-age of mois-ture.	Spe-cific grav-ity.	Cross-bending tests. Dimensions. l.	h.	b.	Modulus of ulti-mate strength. $f=\frac{3\ W\ l}{2\ b\ h^2}$	Modulus of strength at the elastic limit, per square inch. $f=\frac{3\ W_1\ l}{2\ b\ h^2}$	Modulus of elasticity.	Rela-tive elastic resili-ence in inch-pounds per cub. inch.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean)	Strength (mean) per square inch.
					In.	*In.*	*In.*	*Pounds.*				*In.*	*Sq. in.*	*Pounds.*	*In.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*
Log. 1.	2	July 20, 1892	14.6	0.637	60	3.47	3.02	10,340	7,920	1,630,000	2.34	8.0	10.90	6,260	3.43	12.18	1,343	0.653	13,610	4.12	707
								10,084	**7,760**	**1,606,800**	**2.18**			**6,132**			**1,315**				**603**
	3	July 20, 1892	14.8	0.624	60	3.34	2.96	9,570	8,400	1,570,000	2.61	8.0	9.76	6,600	3.30	11.57	1,052	0.672	11,590	3.84	783
								9,442	**8,320**	**1,558,400**	**2.53**			**6,536**			**1,038**				**781**
	5	July 20, 1892	19.4	0.718	60	3.36	3.48	7,970	6,230	1,350,000	1.84	8.0	11.59	5,200	3.34	13.68	855	0.784	11,730	4.00	619
								9,752	**7,430**	**1,454,800**	**2.55**			**6,216**			**1,066**				**660**
	6	July 21, 1892	14.2	0.618	60	3.45	3.49	10,590	8,320	1,580,000	2.56	8.0	11.45	6,440	3.24	13.60	883	0.678	16,450	3.82	812
								10,078	**8,000**	**1,533,600**	**2.23**			**6,184**			**828**				**805**
	7	Nov. 18, 1891	31.3	0.638	60	3.50	3.69	8,700	6,868	1,480,000	1.99	8.3	12.92	4,180	3.62	14.08	788	0.550	15,640	4.16	490
								12,368	**9,598**	**1,739,000**	**3.30**			**6,717**			**1,311**				**640**
	7	Jan. 7, 1892	16.5	0.667	60	3.36	3.40	12,120	10,310	1,843,000	3.37	7.9	11.59	7,070	3.16	12.36	1,529	0.914	12,900	4.12	580
								12,855	**10,800**	**1,889,000**	**3.72**			**7,460**			**1,610**				**594**
	8	July 21, 1892	14.3	0.656	60	3.49	3.22	11,450	8,720	1,740,000	2.57	8.0	10.77	6,670	3.41	12.22	875	0.531	22,500	4.05	862
								11,002	**8,440**	**1,699,400**	**2.29**			**6,446**			**827**				**856**
	9	July 21, 1892	15.3	0.660	60	3.33	3.28	11,690	8,810	1,650,000	2.78	8.0	10.40	7,030	3.27	12.22	929	0.653	15,550	3.75	736
								11,840	**8,910**	**1,659,900**	**2.87**			**7,109**			**946**				**737**
	11	July 21, 1892	13.3	0.583	60	3.20	3.47	8,310	7,090	1,520,000	2.00	8.0	11.31	5,380	3.28	13.52	836	0.688	17,450	4.10	616
								7,152	**6,170**	**1,392,000**	**1.26**			**4,801**			**705**				**601**
	12	Nov. 17, 1891	29.6	0.636	60	3.21	3.54	8,390	6,317	1,520,000	1.55	8.3	11.26	4,360	3.52	12.68	599	0.605	16,530	4.13	532
								11,869	**8,897**	**1,760,200**	**2.80**			**6,742**			**1,090**				**666**
	12	Jan. 7, 1892	16.9	0.449	60	2.97	3.39	11,620	9,388	1,891,600	2.85	7.8	9.88	6,380	3.37	10.78	872	0.816	12,380	4.04	556
								12,543	**9,788**	**1,947,400**	**3.26**			**6,870**			**973**				**573**
	13	Nov. 13, 1891	29.9	0.720	60	3.28	3.73	7,490	5,158	1,350,000	1.24	8.0	11.00	4,865	3.47	12.68	615	0.481	12,690	4.40	556
								11,004	**1,758**	**1,593,800**	**2.51**			**7,276**			**1,112**				**693**
	13	July 21, 1892	16.5	0.711	53	3.07	3.21	12,020	8,670	1,760,000	2.95	8.0	9.98	7,100	3.13	12.51	860	0.853	11,150	3.57	850
								12,755	**9,160**	**1,806,000**	**3.30**			**7,490**			**941**				**864**
	13	Jan. 6, 1852	17.2	0.686	60	3.06	3.44	8,030	7,376	1,425,000	1.76	7.8	10.43	7,190	3.05	12.59	929	0.857	11,000	4.05	532
								9,076	**8,056**	**1,488,200**	**2.22**			**7,750**			**1,041**				**552**
	14	Nov. 18, 1891	30.8	0.713	60	3.21	3.35	10,050	7,302	1,460,000	2.23	8.3	10.62	4,840	3.32	12.76	6,35	0.576	9,720	4.34	600
								13,663	**9,982**	**1,711,000**	**3.52**			**7,332**			**1,149**				**745**
	14	Jan. 7, 1892	18.0	0.725	60	3.11	3.29	14,320	12,220	2,346,000	4.13	7.9	10.32	8,120	3.33	11.59	949	0.860	18,140	3.60	791
								15,670	**13,110**	**2,426,000**	**4.69**			**8,860**			**1,092**				**819**
	15	July 22, 1892	13.7	0.584	60	3.04	3.39	11,160	8,910	1,700,000	2.77	8.0	10.40	6,500	3.41	12.07	963	0.700	14,110	3.82	476
								10,298	**8,290**	**1,612,000**	**2.22**			**6,069**			**868**				**464**
	16	July 22, 1892	16.2	0.669	60	3.26	3.11	10,710	8,720	1,700,000	2.56	8.0	10.45	6,270	3.35	12.46	1,445	0.719	21,390	3.51	628
								11,304	**9,120**	**1,738,200**	**2.85**			**6,585**			**1,511**				**638**
	17	Nov. 16, 1891	35.5	0.688	60	3.47	3.65	6,960	5,077	1,270,000	1.25	8.5	12.49	3,524	3.87	13.68	614	0.681	14,090	4.18	377
								11,038	**8,127**	**1,571,000**	**2.68**			**6,407**			**1,206**				**566**
	17	Jan. 7, 1892	12.3	0.545	60	3.31	3.58	9,960	7,616	1,372,000	2.40	7.9	11.78	5,980	3.57	12.18	1,084	0.810	13,200	4.28	657
								8,076	**5,556**	**1,118,800**	**1.20**			**4,960**			**813**				**632**
	17	July 21, 1892	15.9	0.612	53	3.05	3.44	9,940	7,500	1,490,000	2.37	8.0	10.40	5,690	3.36	12.26	776	0.721	16,980	3.80	614
								10,390	**7,810**	**1,519,700**	**2.60**			**5,929**			**826**				**622**
	18	July 22, 1892	14.2	0.667	60	2.91	3.25	10,460	7,190	1,620,000	1.97	8.0	9.18	6,470	3.24	11.55	734	0.728	12,610	3.70	800
								9,948	**6,870**	**1,573,600**	**1.64**			**6,214**			**679**				**793**



Log. 1.

	19	July 22, 1892	16.0	0.750	60	2.86	3.20	12,140	10,660	2,160,000	3.20	7.4	8.64	*6,860	3.11	10.89	950	0.738	15,670	3.70	794
								12,640	**11,000**	**2,193,000**	**3.45**			**7,125**			**1,006**				**803**
	20	Nov. 16, 1891	27.3	0.686	60	3.47	3.48	8,190	6,871	1,410,000	1.89	8.4	12.01	4,665	3.70	13.60	654	0.344	†13,940	4.04	521
								11,390	**9,231**	**1,622,600**	**3.05**			**6,808**			**1,099**				**634**
	20	Jan. 7, 1892	18.4	0.677	60	3.30	3.42	11,600	9,668	1,758,000	3.07	7.8	11.09	6,770	3.28	12.33	1,014	0.885	9,490	4.14	655
								13,078	**10,648**	**1,845,200**	**3.68**			**7,590**			**1,183**				**687**
		July 22, 1892	15.7	0.689	53	3.56	3.09	13,090	8,930	1,870,000	2.61	8.0	11.27	7,200	3.79	12.42	944	0.750	18,240	4.18	678
								13,440	**9,170**	**1,893,100**	**2.80**			**7,386**			**983**				**684**
	21	July 22, 1892	14.4	0.687	60	3.18	3.07	11,590	8,390	1,970,000	2.34	8.0	9.32	6,980	3.13	11.51	1,459	0.812	18,830	3.60	682
								11,206	**8,450**	**1,935,200**	**2.10**			**6,788**			**1,418**				**677**
	22	July 22, 1892	18.8	0.705	60	3.46	3.32	10,790	7,590	1,650,000	2.25	8.0	11.31	6,140	3.46	12.73	1,288	0.797	11,750	3.97	746
								12,396	**8,660**	**1,744,400**	**2.90**			**7,040**			**1,474**				**781**
Log 1.	23	July 22, 1892	14.4	0.576	60	3.37	3.07	8,780	7,020	1,520,000	1.90	8.0	8.28	5,550	2.98	10.93	874	0.872	12,390	3.98	832
								8,396	**6,780**	**1,485,200**	**1.66**			**5,358**			**833**				**827**
	24	July 23, 1892	16.3	0.664	60	3.28	3.27	10,850	8,960	1,730,000	2.70	8.0	10.18	7,228	3.20	12.85	954	0.794	15,650	3.72	701
								11,491	**9,390**	**1,770,800**	**3.01**			**7,568**			**1,025**				**713**
	25	July 23, 1892	15.4	0.677	60	3.26	3.41	12,430	8,550	1,920,000	2.29	8.0	10.46	7,320	3.28	12.65	1,007	0.732	17,680	3.82	788
								12,630	**8,690**	**1,933,200**	**2.41**			**7,426**			**1,029**				**792**
	26	July 23, 1892	14.3	0.667	60	3.48	3.39	11,040	8,770	1,740,000	2.52	8.0	11.46	7,060	3.32	13.52	1,013	0.775	16,710	3.76	840
								10,592	**9,050**	**1,699,400**	**2.24**			**6,836**			**965**				**834**
	27	Dec. 7, 1891	33.2	0.639	60	2.86	3.39	7,870	5,844	1,530,000	1.41	8.3	10.12	4,210	3.48	10.56	568	0.541	15,520	4.23	574
								11,730	**8,724**	**1,808,000**	**2.78**			**6,911**			**1,124**				**742**
		July 23, 1892	15.7	0.662	60	3.19	2.65	11,350	8,010	1,880,000	2.21	8.0	8.29	6,790	3.13	10.53	883	0.588	19,150	3.61	872
								11,700	**8,250**	**1,903,100**	**2.40**			**6,976**			**922**				**878**
	28	July 23, 1892	21.4	0.752	60	3.30	3.36	9,900	7,620	1,570,000	2.15	8.0	8.37	5,810	3.31	10.06	670	0.682	‡14,000	3.88	760
								12,164	**9,210**	**1,706,600**	**3.00**			**7,186**			**954**				**819**
	29	Nov. 18, 1891	39.2	0.830	60	3.39	3.46	6,970	4,523	1,440,000	0.91	8.2	11.56	3,980	3.46	13.40	522	0.692	15,470	4.24	538
								11,399	**7,803**	**1,778,000**	**2.41**			**7,118**			**1,166**				**760**
	29	Jan. 7, 1892	19.6	0.583	60	3.39	3.39	9,390	6,932	1,227,000	1.89	7.9	11.12	6,280	3.35	12.25	1,069	0.860	14,180	3.81	745
								11,228	**8,182**	**1,335,200**	**2.62**			**7,334**			**1,288**				**787**
	30	July 23, 1892	16.6	0.660	60	3.99	3.31	10,690	8,020	1,810,000	2.23	8.0	10.30	6,510	3.27	12.42	1,135	0.570	13,850	3.80	484
								11,472	**8,530**	**1,858,600**	**2.60**			**6,925**			**1,221**				**498**
	31	July 23, 1892	14.5	0.649	60	3.30	3.47	10,050	8,760	1,600,000	2.94	8.0	11.24	7,230	3.26	13.68	1,011	0.766	18,470	3.78	744
								9,730	**8,560**	**1,571,000**	**2.74**			**7,070**			**977**				**740**
Log 1.	32	July 23, 1892	14.8	0.674	60	3.27	3.17	10,820	8,880	1,790,000	2.57	8.0	9.67	7,220	3.14	12.06	880	0.623	21,930	3.34	834
								10,692	**8,800**	**1,778,400**	**2.49**			**7,156**			**866**				**831**
	2	Nov. 13, 1891	76.1	0.907	60	3.38	3.60	5,500	3,941	1,170,000	1.64	8.0	10.82	3,760	3.25	13.08	520	0.803	10,960	4.26	420
								13,435	**8,664**	**1,877,000**	**3.74**			**8,655**			**1,519**				**982**
		July 25, 1892	14.1	0.523	60	3.47	2.84	8,970	6,520	1,550,000	1.86	8.0	10.17	5,370	3.47	11.40	991	0.778	§11,460	3.92	646
								8,394	**6,160**	**1,497,800**	**1.48**			**5,082**			**929**				**638**
	8	Dec. 2, 1891	32.8	0.648	60	3.50	3.38	7,590	7,654	1,340,000	1.44	8.0	11.86	4,070	3.48	12.55	645	0.725	13,790	4.14	516
								11,410	**10,514**	**1,614,000**	**2.79**			**6,738**			**1,195**				**680**
		July 25, 1892	15.2	0.547	60	3.46	3.18	9,640	7,570	1,520,000	2.26	8.0	11.14	5,950	3.47	12.46	894	0.645	13,030	4.02	564
								9,740	**7,640**	**1,526,600**	**2.32**			**6,003**			**905**				**566**
	18	Nov. 13, 1891	41.7	0.800	60	3.20	3.20	6,460	4,944	1,240,000	1.24	8.0	10.14	3,372	3.22	12.68	513	0.653	11,940	4.39	376
								11,127	**8,370**	**1,603,000**	**2.79**			**6,669**			**1,189**				**621**
		July 25, 1892	14.0	0.496	60	3.27	3.08	8,090	6,770	1,300,000	2.22	8.1	9.91	5,320	3.24	11.99	1,068	0.722	12,600	3.68	582
								7,450	**6,370**	**1,242,000**	**1.79**			**5,000**			**999**				**573**
	21	Nov. 13, 1891	33.6	0.590	60	3.56	3.31	6,870	5,151	1,270,000	1.23	8.0	11.87	3,832	3.64	13.12	579	0.700	16,500	4.10	546
								10,769	**8,061**	**1,552,000**	**2.61**			**6,565**			**1,142**				**717**
		July 26, 1892	14.0	0.564	60	3.36	3.32	9,250	7,200	1,400,000	2.15	8.0	11.15	5,840	3.37	12.93	804	0.625	15,840	3.63	732
								8,610	**6,800**	**1,402,000**	**1.72**			**5,520**			**735**				**723**
	1	Aug. 6, 1892	15.7	0.518	60	3.02	2.80	8,600	7,050	1,400,000	2.13	8.0	8.49	6,240	3.02	11.12	857	0.791	12,310	4.04	729
								8,950	**7,290**	**1,423,100**	**2.32**			**6,426**			**896**				**671**
	4	Aug. 8, 1892	13.4	0.546	60	3.41	3.30	11,260	8,450	1,570,000	2.81	8.1	11.18	6,550	3.43	12.97	1,026	0.638	13,600	3.81	790
								10,176	**7,600**	**1,452,000**	**2.12**			**6,008**			**904**				**922**
		Oct. 19, 1892	11.6	0.556	60	3.23	3.04	13,110	10,500	1,792,000	4.07	8.0	9.52	8,620	3.22	12.07	1,542	0.840	10,000	3.88	527
								10,710	**7,530**	**1,443,600**	**2.56**			**7,236**			**1,207**				**807**
	5	Aug. 6, 1892	13.7	0.545	60	3.17	3.14	10,270	8,560	1,510,000	2.96	8.0	9.98	6,390	3.15	12.46	1,332	0.788	12,160	3.69	740
								9,408	**7,940**	**1,422,000**	**2.41**			**5,959**			**1,237**				**848**
		Oct. 20, 1892	10.5	0.556	60	3.10	3.16	12,950	10,960	1,720,000	3.12	8.0	9.83	8,200	3.13	12.46	1,513	0.625	14,000	3.51	522
								9,720	**6,560**	**1,222,000**	**1.10**			**6,000**			**1,019**				**894**
Log 2.	6	Aug. 16, 892	13.4	6.540	60	3.45	3.28	10,140	8,070	1,440,000	2.09	8.1	11.07	6,210	3.19	13.68	929	0.688	9,260	3.85	929
								9,056	**7,220**	**1,322,000**	**2.11**			**5,668**			**807**				**1,061**
	7	July 25, 1892	13.9	0.515	60	3.20	3.47	9,340	7,360	1,450,000	2.09	8.0	11.46	5,060	3.44	11.12	897	0.803	13,070	4.00	627
								8,626	**6,890**	**1,382,000**	**1.62**			**4,703**			**819**				**718**
	9	Aug. 6, 1892	13.0	0.576	60	3.44	3.19	11,160	9,060	1,410,000	3.43	8.0	10.50	6,390	3.48	12.03	968	0.640	11,660	3.94	768
								9,780	**7,910**	**1,252,000**	**2.54**			**5,700**			**811**				**933**
		Oct. 19, 1892	11.5	0.620	60	3.00	3.01	12,760	11,300	1,860,000	4.08	8.0	9.12	8,180	3.02	11.67	1,054	0.780	10,000	3.05	868
								10,285	**8,200**	**1,498,000**	**2.52**			**6,740**			**705**				**1,156**



*Season checked. † Crossgrained. ‡ Very resinous. § Broke in grips.

TABLE I.—CONDENSED RESULTS OF INDIVIDUAL TESTS ON LONG-LEAF YELLOW PINE—Continued.

TREE No. 52—Continued.

[Reduced results at 15 per cent moisture given in bold-faced type.]

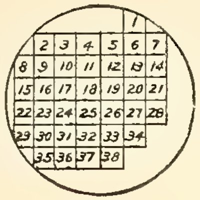
Log number and method of cutting.	No. of stick.	Date of test.	Per-centage of moisture.	Specific gravity.	Cross-bending tests. Dimensions. l.	h.	b.	Modulus of ultimate strength. $f'=\frac{3\,W\,l}{2\,b\,h^2}$	Modulus of strength at the elastic limit per square inch. $f=\frac{3\,W_1\,l}{2\,b\,h^2}$	Modulus of elasticity.	Relative elastic resilience in inch-pounds per cub. inch.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean).	Strength (mean) per square inch.
					In.	*In.*	*In.*	*Pounds.*				*In.*	*Sq. in.*	*Pounds.*	*In.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*
Log 2—Continued.	10	Aug. 8, 1892	14.1	0.566	60	3.27	3.26	*9,560	7,230	1,370,000	2.41	6.1	4.91	6,800	2.66	9.27	1,268	0.653	11,190	4.84	685
								8,984	**6,870**	**1,317,800**	**2.06**			**6,512**			**1,206**				**759**
	11	Aug. 8, 1892	14.3	0.535	60	3.30	3.33	10,620	8,690	1,440,000	3.25	8.1	10.98	5,810	3.36	12.93	1,036	0.653	9,470	3.84	733
								10,172	**8,410**	**1,399,400**	**2.97**			**5,586**			**988**				**792**
	11	Oct. 21, 1892	11.7	0.533	60	3.36	3.16	12,510	9,585	1,757,000	3.13	8.0	10.55	7,940	3.17	13.16	1,186	0.598	7,760	3.57	526
								10,185	**6,745**	**1,422,200**	**1.66**			**6,612**			**866**				**798**
	12	Aug. 8, 1892	12.7	0.522	60	2.93	2.68	8,370	6,260	1,440,000	1.64	8.1	8.29	5,690	2.92	11.00	952	0.655	10,940	3.98	610
								6,774	**4,720**	**1,211,200**	**0.63**			**4,859**			**759**				**800**
	13	Aug. 8, 1892	12.5	0.519	60	3.47	3.06	9,770	8,060	1,440,000	2.79	8.1	10.83	6,350	3.47	12.42	1,508	0.728	14,560	3.95	532
								8,030	**6,260**	**1,214,000**	**1.69**			**5,425**			**1,291**				**738**
	14	Aug. 8, 1892	13.1	0.550	60	3.02	3.22	10,570	8,270	1,580,000	2.67	8.1	10.98	6,610	3.26	12.30	1,114	0.735	12,860	3.69	601
								9,264	**7,200**	**1,432,000**	**1.83**			**5,957**			**966**				**758**
	15	Aug. 8, 1892	11.9	0.555	60	3.28	3.01	10,460	9,120	1,470,000	3.66	8.1	10.55	6,450	3.34	12.18	1,017	0.678	13,740	3.72	673
								8,285	**6,540**	**1,162,400**	**2.27**			**5,214**			**756**				**928**
	16	Aug. 8, 1892	12.4	0.630	60	3.14	2.87	11,180	8,530	1,430,000	3.16	8.1	8.29	*6,690	3.10	11.59	1,172	0.598	7,560	4.02	710
								9,368	**6,600**	**1,190,400**	**2.01**			**5,718**			**913**				**925**
	16	Oct. 19, 1892	11.7	0.633	60	3.07	2.87	9,320	9,021	1,671,000	3.02	8.0	10.83	8,560	3.05	11.28	1,183	0.669	11,960	4.21	602
								7,995	**6,184**	**1,336,200**	**1.55**			**7,232**			**863**				**874**
	17	Aug. 9, 1892	13.1	0.550	60	3.11	2.96	10,690	8,330	1,520,000	2.75	8.1	8.58	6,980	2.93	11.40	1,200	0.690	13,690	3.65	610
								9,384	**7,260**	**1,372,000**	**1.91**			**6,327**			**1,061**				**767**
	17	Oct. 19, 1892	11.1	0.531	60	3.13	3.00	12,060	10,650	1,644,000	4.09	7.8	9.39	7,850	3.17	11.79	1,320	0.717	†8,120	3.53	*460
								9,285	**7,030**	**1,227,600**	**2.33**			**6,184**			**913**				**782**
	20	Aug. 9, 1892	14.4	0.552	60	3.24	3.29	11,020	8,470	1,510,000	2.78	8.0	10.72	6,750	3.29	12.77	1,096	0.740	13,070	3.53	717
								10,636	**8,230**	**1,505,200**	**2.54**			**6,558**			**1,055**				**767**
	20	Oct. 19, 1892	12.9	0.568	60	3.24	3.04	13,110	9,869	1,932,000	2.95	8.0	9.72	7,720	2.94	12.81	1,085	0.680	12,680	3.52	‡513
								11,658	**8,589**	**1,760,400**	**2.02**			**6,983**			**916**				**686**
	22	Aug. 9, 1892	13.9	0.545	60	3.52	3.09	9,140	8,510	1,420,000	2.28	8.0	10.59	5,990	3.44	11.95	1,086	0.632	8,540	4.06	608
								8,426	**8,040**	**1,352,000**	**1.81**			**5,633**			**1,008**				**699**
	22	Oct. 19, 1892	10.5	0.538	60	3.15	3.13	†8,140	6,953	1,518,000	2.11	8.0	9.73	7,400	3.13	12.22	1,407	0.887	7,670	3.59	496
								4,910	**2,553**	**1,020,000**	**0.09**			**5,400**			**913**				**868**
	23	Aug. 9, 1892	12.6	0.534	60	3.26	3.10	10,140	7,730	1,510,000	2.54	8.1	10.11	6,280	3.22	12.22	1,010	0.645	9,680	3.73	745
								8,472	**6,060**	**1,297,600**	**1.49**			**5,402**			**805**				**943**
	23	Oct. 19, 1892	12.4	0.517	60	3.11	2.93	9,180	8,894	1,593,000	3.16	8.0	9.17	7,520	3.13	11.48	1,098	0.725	9,000	3.45	684
								7,368	**6,964**	**1,353,400**	**2.01**			**6,548**			**869**				**900**
	25	Aug. 9, 1892	13.0	0.511	60	3.51	3.22	§7,260	5,670	1,280,000	1.65	8.1	10.91	6,090	3.54	11.95	937	0.602	6,970	3.84	§550
								5,880	**4,520**	**1,122,000**	**0.76**			**5,400**			**780**				**716**
	25	Oct. 19, 1892	12.1	0.545	60	2.97	2.97	12,540	10,030	1,631,000	3.94	6.0	8.53	6,850	2.93	11.44	1,591	0.787	12,680	3.76	539
								10,512	**7,710**	**1,350,600**	**2.64**			**5,737**			**1,326**				**776**
	26	Aug. 9, 1892	13.0	0.503	60	3.67	3.47	6,330	6,160	1,160,000	1.99	8.1	12.63	5,460	3.66	13.48	1,061	0.650	7,080	3.95	495
								4,950	**5,010**	**1,002,000**	**1.10**			**4,770**			**907**				**660**

* Wind shaken. † Knot. ‡ Failed by tension. § Season checked.

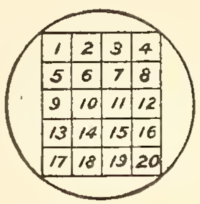
[Species: *Pinus palustris*. Habitat: Wilson, Ala.; good pine land; well timbered. **TREE No. 53**; cut October, 1891; sawed November, 1891; age, 192 years.]

LOG DIAGRAM:

LOG 1. 30" 20'0" — LOG 2. 22" 12'0"



Log 1.



Log 2.

9	Dec. 7, 1891	47.9	0.725	60	3.39	3.61	6,330 / **11,585**	5,424 / **9,154**	1,210,000 / **1,300,150**	1.55 / **3.20**	8.2	12.10	3,560 / **7,185**	3.61	12.48	417 / **1,162**	0.628	12,430	3.90	482 / **785**
	July 25, 1892	19.2	0.724	60	3.52	3.46	8,900 / **10,626**	6,930 / **8,090**	1,290,000 / **1,301,510**	2.23 / **2.92**	8.0	11.94	5,760 / **6,738**	3.42	13.40	788 / **991**	0.790	11,780	4.00	742 / **780**
12	Nov. 17, 1891	30.7	0.772	60	3.37	3.54	8,380 / **11,982**	6,719 / **9,389**	1,550,000 / **1,593,010**	1.87 / **3.16**	8.1	11.76	4,590 / **7,073**	3.43	13.64	616 / **1,128**	0.452	15,490	4.38	452 / **596**
	July 26, 1892	17.7	0.780	55	3.41	3.02	10,140 / **11,376**	7,520 / **8,330**	1,910,000 / **1,913,390**	1.84 / **2.37**	8.0	10.24	6,870 / **7,543**	3.36	11.99	918 / **1,056**	0.762	13,120	3.98	481 / **506**
12	Jan. 7, 1892	14.9	0.694	60	2.97	3.58	11,150 / **11,086**	8,780 / **8,740**	1,756,000 / **1,755,730**	2.48 / **2.44**	7.9	10.77	5,940 / **5,908**	3.55	10.67	947 / **940**	0.728	13,190	3.98	592 / **589**
23	Nov. 16, 1891	31.3	0.723	60	3.50	3.63	7,950 / **11,618**	6,315 / **9,045**	1,530,000 / **1,574,660**	1.54 / **2.85**	8.4	12.57	4,361 / **6,898**	3.59	14.12	744 / **1,267**	0.595	12,100	4.00	527 / **677**
	July 26, 1892	20.7	0.800	54	3.44	3.55	10,120 / **12,231**	7,710 / **9,170**	1,530,000 / **1,545,610**	2.30 / **3.11**	8.0	12.14	5,550 / **6,806**	3.47	12.42	1,540 / **1,800**	0.750	14,960	4.03	494 / **547**
23	Jan. 7, 1892	20.6	0.698	60	3.45	3.59	9,820 / **11,908**	8,008 / **9,448**	1,391,000 / **1,406,340**	2.69 / **3.49**	7.9	12.46	5,940 / **7,178**	3.59	12.70	976 / **1,233**	0.781	10,240	4.21	522 / **573**
30	Nov. 17, 1891	32.1	0.682	60	3.49	3.49	7,480 / **11,230**	6,224 / **9,024**	1,330,000 / **1,376,850**	1.83 / **3.16**	8.2	11.73	4,561 / **7,170**	3.41	13.60	485 / **1,023**	0.708	13,850	4.36	574 / **732**
30	Jan. 7, 1892	21.5	0.638	60	3.35	3.35	9,440 / **11,725**	7,188 / **8,798**	1,286,000 / **1,303,810**	2.02 / **2.88**	7.9	11.15	5,740 / **7,133**	3.36	12.07	812 / **1,100**	0.882	9,760	3.76	622 / **681**
	July 26, 1892	19.4	0.757	54	3.31	3.37	9,280 / **11,062**	7,020 / **8,220**	1,480,000 / **1,492,060**	1.96 / **2.67**	8.0	10.92	5,700 / **6,716**	3.36	12.89	807 / **1,018**	0.797	12,470	3.84	812 / **853**
31	Nov. 16, 1891	30.7	0.774	60	3.46	3.50	8,260 / **11,862**	7,306 / **9,976**	1,620,000 / **1,663,010**	2.02 / **3.31**	8.4	11.66	4,881 / **7,364**	3.49	13.20	636 / **1,148**	0.650	16,150	4.23	467 / **611**
	July 27, 1892	18.2	0.778	53	3.33	3.19	8,650 / **10,064**	6,740 / **7,680**	1,390,000 / **1,398,770**	2.17 / **2.76**	8.0	10.46	5,900 / **6,680**	......	......	......	0.616	8,760	3.70	907 / **937**
31	Jan. 6, 1892	21.4	0.730	60	3.28	3.25	10,400 / **12,664**	8,440 / **10,030**	1,544,000 / **1,561,540**	2.49 / **3.34**	7.9	10.66	6,340 / **7,716**	3.24	11.96	962 / **1,246**	0.882	9,520	3.66	572 / **681**
33	Nov. 17, 1891	30.4	0.795	60	3.38	3.46	9,020 / **10,589**	7,289 / **9,939**	1,820,000 / **1,862,200**	1.78 / **3.06**	8.0	11.22	5,160 / **7,616**	3.35	13.16	509 / **1,016**	0.647	17,300	4.15	529 / **671**
33	Jan. 6, 1892	22.4	0.763	60	3.13	3.27	10,690 / **13,154**	8,428 / **10,178**	1,589,000 / **1,609,280**	2.07 / **2.98**	7.8	10.14	6,930 / **8,465**	3.27	11.48	927 / **1,243**	0.810	18,530	3.89	616 / **684**
37	Nov. 17, 1891	30.0	0.723	60	3.44	3.89	7,660 / **11,185**	6,161 / **8,770**	1,470,000 / **1,511,100**	1.55 / **2.82**	8.3	13.24	3,808 / **6,228**	3.87	13.60	610 / **1,109**	0.696	12,640	4.26	528 / **666**
	Jan. 7, 1892	20.9	0.639	60	3.28	3.79	9,270 / **11,427**	7,063 / **8,563**	1,312,000 / **1,328,170**	2.09 / **2.91**	7.8	12.35	5,510 / **6,802**	3.80	11.92	973 / **1,240**	0.904	13,940	4.39	478 / **532**
37	July 27, 1892	20.3	0.708	54	3.31	3.68	9,120 / **11,139**	8,840 / **10,230**	1,330,000 / **1,344,520**	3.56 / **4.34**	8.1	12.12	5,450 / **6,634**	3.62	13.16	978 / **1,224**	1.063	14,960	4.08	617 / **666**
14	July 28, 1892	13.0	0.623	60	2.86	3.21	11,830 / **10,450**	8,500 / **7,350**	1,730,000 / **1,572,000**	2.72 / **1.83**	8.1	9.16	6,910 / **6,220**	3.19	11.46	832 / **675**	0.786	11,240	3.64	705 / **870**
3	Nov. 27, 1891	58.8	0.750	60	3.51	3.74	*3,910 / **10,201**	3,558 / **7,852**	852,000 / **972,010**	1.03 / **2.85**	8.0	12.88	2,840 / **6,956**	3.69	12.81	469 / **1,312**	0.800	*3,500	3.84	448 / **851**
	July 26, 1892	17.5	0.629	60	3.48	3.23	8,510 / **9,670**	7,270 / **8,030**	1,190,000 / **1,196,850**	2.40 / **2.91**	8.0	11.49	4,980 / **5,608**	3.46	12.81	1,173 / **1,302**	0.700	9,090	3.40	574 / **598**
9	Nov. 27, 1891	32.0	0.692	60	3.54	3.46	8,260 / **12,000**	6,018 / **8,808**	1,370,000 / **1,416,580**	1.78 / **3.11**	9.0	11.64	4,150 / **6,750**	3.45	11.78	662 / **1,198**	0.904	8,410	4.16	518 / **674**
	July 25, 1892	16.5	0.608	60	3.48	3.51	10,380 / **11,115**	7,620 / **8,110**	1,420,000 / **1,424,110**	2.54 / **2.89**	8.0	12.11	6,080 / **6,470**	3.50	13.72	903 / **984**	......	......	4.02	750 / **764**
12	Nov. 20, 1891	30.8	0.692	60	3.23	3.56	6,930 / **10,543**	6,305 / **8,985**	1,210,000 / **1,253,290**	1.58 / **2.87**	8.0	11.33	4,323 / **6,815**	3.05	11.32	866 / **1,380**	0.645	12,400	4.15	518 / **663**
	July 26, 1892	17.0	0.687	60	3.51	3.06	8,160 / **9,130**	6,680 / **7,310**	1,310,000 / **1,315,480**	2.11 / **2.53**	8.0	10.78	5,840 / **6,355**	3.50	12.22	1,059 / **1,165**	0.590	8,750	4.07	744 / **762**
18	Nov. 27, 1891	24.9	0.683	60	3.35	3.64	8,340 / **11,210**	6,520 / **8,620**	1,340,000 / **1,367,130**	1.97 / **3.02**	9.0	12.12	6,520 / **8,393**	3.62	12.33	815 / **1,203**	0.803	12,950	3.98	604 / **696**
	Aug. 1, 1892	18.2	0.654	60	3.47	3.48	8,380 / **9,794**	6,450 / **7,390**	1,190,000 / **1,198,770**	2.27 / **2.86**	8.1	11.94	5,510 / **6,290**	3.48	13.60	1,008 / **1,169**	0.797	10,530	3.68	626 / **656**
2	Sept. 6, 1892	13.7	0.538	60	3.59	3.39	*6,240 / **5,378**	6,240 / **5,620**	930,000 / **842,000**	2.45 / **1.90**	8.0	11.89	5,460 / **5,029**	3.36	14.03	783 / **688**	0.630	6,290	3.84	633 / **633**
	Oct. 21, 1892	16.6	0.603	60	3.36	3.34	†9,090 / **8,308**	8,350 / **8,860**	1,172,000 / **1,220,600**	3.94 / **4.31**	8.0	9.82	7,070 / **7,485**	3.32	13.05	1,235 / **1,321**	0.833	6,370	4.04	‡780 / **780**
6	Sept. 7, 1892	14.4	0.488	60	3.59	3.73	5,760 / **5,376**	5,830 / **5,596**	1,080,000 / **1,045,200**	1.54 / **1.30**	8.0	13.54	5,010 / **4,818**	3.71	14.42	1,055 / **1,014**	0.662	§6,340	3.91	640 / **640**
	Oct. 19, 1892	12.3	0.490	60	3.35	3.23	7,400 / **5,516**	7,202 / **5,142**	1,267,000 / **1,013,800**	2.61 / **1.41**	8.0	10.82	5,800 / **4,781**	3.27	13.24	1,017 / **776**	0.766	8,090	3.51	‡507 / **507**

* Crossgrained. † Knot. ‡ Failed in tension. § Broke in grips.

TABLE I.—Condensed Results of Individual Tests on Long-leaf Yellow Pine—Continued.

[Reduced results at 15 per cent moisture given in bold-faced type.]

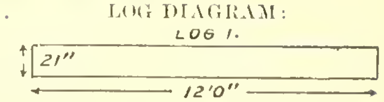
TREE No. 53.—Continued.

Log number and method of cutting.	No. of stick.	Date of test.	Per-centage of moisture.	Specific gravity.	Cross-bending tests. Dimensions. l.	h.	b.	Modulus of ultimate strength. $f=\frac{3\ W\ l}{2\ b\ h^2}$	Modulus of strength at the elastic limit, per square inch. $f=\frac{3\ W_1\ l}{2\ b\ h^2}$	Modulus of elasticity.	Relative elastic resilience in inch-pounds per cub. inch.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean)	Strength (mean) per square inch.
					In.	*In.*	*In.*	*Pounds.*				*In.*	*Sq. in.*	*Pounds.*	*In.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*
Log 2—Continued.	8	Sept. 6, 1892	12.9	0.644	60	3.30	3.47	5,720	4,770	1,490,000	0.90	8.0	11.52	6,970	3.47	13.17	1,328	0.628	11,190	3.72	584
								4,268	**3,190**	**1,318,400**				**6,233**			**1,159**				**584**
		Oct. 20, 1892	13.3	0.672	60	3.16	3.20	7,580	6,763	1,498,000	1.77	8.0	10.05	8,790	3.23	12.57	1,249	0.711	8,710	3.71	565
								6,422	**5,843**	**1,370,000**	**1.03**			**8,211**			**1,418**				**565**
	11	Sept. 7, 1892	14.5	0.484	60	3.45	3.58	8,410	8,410	918,000	3.97	8.0	12.28	4,980	3.58	13.56	913	0.769	8,320	3.90	607
								8,080	**8,210**	**889,000**	**3.77**			**4,820**			**879**				**607**
		Oct. 20, 1892	12.1	0.488	60	3.28	3.15	8,790	7,967	1,142,000	3.50	8.0	10.24	5,700	3.14	12.85	1,074	0.722	8,580	3.47	578
								6,762	**5,647**	**861,600**	**2.20**			**4,587**			**809**				**578**
	13	Sept. 6, 1892	13.4	0.659	60	3.48	3.17	10,550	9,496	1,660,000	3.69	8.0	11.06	7,660	3.51	12.58	1,965	0.605	11,340	3.97	582
								9,466	**8,646**	**1,542,000**	**3.00**			**7,118**			**1,743**				**582**
		Oct. 21, 1892	12.8	0.654	60	3.37	3.11	12,150	10,450	1,656,000	4.28	8.0	10.36	8,890	3.14	12.97	1,222	0.583	10,480	3.65	*662
								10,626	**9,040**	**1,470,800**	**3.31**			**8,106**			**1,011**				**662**
	14	Sept. 6, 1892	13.2	0.650	60	3.59	8.18	11,750	9,664	1,840,000	3.21	8.0	11.28	6,990	3.59	12.38	1,242	0.753	11,020	3.91	651
								10,518	**8,664**	**1,702,000**	**2.42**			**6,374**			**1,103**				**651**
		Oct. 21, 1892	13.0	0.728	60	3.38	3.19	†11,850	11,850	1,819,000	5.00	8.0	10.68	†6,730	3.37	12.58	1,392	0.663	8,060	3.60	553
								10,470	**10,700**	**1,661,000**	**4.11**			**6,040**			**1,235**				**553**
	15	Sept. 7, 1892	16.4	0.561	60	3.12	3.34	5,950	5,950	1,010,000	1.95	8.0	10.10	5,360	3.31	12.02	814	0.750	9,260	3.87	511
								6,638	**6,110**	**1,053,400**	**2.27**			**5,725**			**890**				**511**
		Oct. 20, 1892	14.1	0.632	60	3.22	3.00	10,180	9,543	1,375,000	4.12	8.0	9.69	7,350	3.26	11.67	1,277	0.633	4,170	3.71	484
								9,604	**9,183**	**1,322,800**	**3.76**			**7,062**			**1,215**				**484**

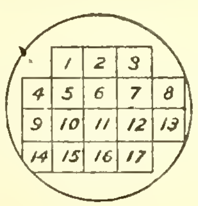
* Failed in tension.

† Knot.

LOG DIAGRAM:



[Species: *Pinus palustris*. Habitat: Wilson, Ala.; good pine land; well timbered. **TREE No. 54**: cut October, 1891; sawed November, 1891; age, 180 years.]

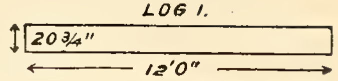
 Log 1.	2	Nov. 20, 1891	28.6	0.702	60	3.40	3.61	8,760	6,581	1,560,000	1.81	8.0	12.65	4,625	3.31	12.64	918	0.619	19,720	4.10	665
								12,122	**9,071**	**1,788,200**	**3.02**			**6,908**			**1,390**				**975**
		July 27, 1892	16.8	0.904	60	3.46	3.50	12,260	9,280	1,820,000	2.93	8.0	12.14	6,500	3.47	13.72	1,554	0.550	25,450	3.84	794
								13,136	**9,850**	**1,873,800**	**3.33**			**6,965**			**1,650**				**845**
	7	Nov. 27, 1891	27.9	0.779	60	3.36	3.60	9,660	7,968	1,780,000	2.34	8.7	11.81	5,760	3.60	11.92	822	0.853	15,940	4.07	564
								12,936	**10,388**	**1,999,800**	**3.53**			**7,969**			**1,280**				**862**
		July 27, 1892	16.6	0.854	60	3.47	3.51	12,060	8,690	1,990,000	2.41	8.0	12.11	7,090	3.50	13.56	1,054	0.896	21,470	3.91	736
								12,842	**9,200**	**2,038,600**	**2.78**			**7,504**			**1,140**				**782**
	9	Dec. 2, 1891	27.4	0.648	60	3.21	3.33	8,240	4,724	1,690,000	1.89	8.0	10.39	4,690	3.31	11.63	1,195	0.789	19,020	4.36	†567
								11,453	**7,091**	**1,903,800**	**3.06**			**6,844**			**1,612**				**858**
		July 28, 1892	16.9	0.891	60	3.33	2.87	12,660	9,380	1,940,000	2.90	8.1	9.05	6,680	3.26	10.77	1,529	0.687	22,420	3.78	828
								13,583	**9,980**	**1,996,400**	**3.31**			**7,170**			**1,630**				**882**
	16	Nov. 24, 1891	29.3	0.817	59.5	3.50	3.44	9,590	7,011	1,680,000	1.80	8.4	11.70	*5,450	3.45	12.44	699	0.625	12,480	3.82	641
								13,035	**9,561**	**1,916,600**	**3.04**			**7,804**			**1,185**				**961**
		July 27, 1892	16.2	0.843	60	3.50	3.45	12,350	9,110	1,750,000	2.86	8.0	12.04	7,180	3.50	13.56	1,119	0.672	18,220	3.78	1,036
								12,944	**9,510**	**1,788,200**	**3.15**			**7,495**			**1,185**				**1,072**

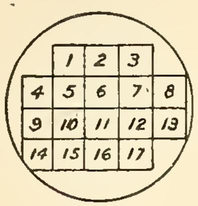
* Wind shaken.

† Knot.

[Species: *Pinus palustris*. Habitat: Wilson, Ala; good pine land; well timbered. **TREE No. 55**; cut October, 1891; sawed November, 1891.]

LOG DIAGRAM:





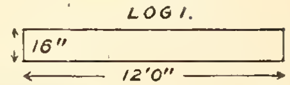
Log 1.

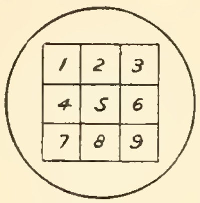
2	Nov. 27, 1891	28.0	0.668	60	3.36	3.54	9,910 **13,199**	8,649 **11,070**	1,770,000 **1,991,000**	2.19 **3.38**	7.7	11.93	5,190 **7,410**	3.52	12.25	865 **1,325**	0.675	18,370	4.20	388 **689**
	July 28, 1892	14.4	0.652	60	3.29	3.27	10,920 **10,536**	8,850 **8,570**	1,760,000 **1,725,200**	2.74 **2.50**	8.0	10.59	6,750 **6,558**	3.26	12.97	1,168 **1,127**	0.793	16,150	3.68	552 **535**
6	Nov. 13, 1891	27.5	0.736	60	3.38	3.30	8,690 **11,916**	7,640 **10,020**	1,530,000 **1,745,000**	2.24 **3.41**	8.4	10.89	5,528 **7,693**	3.29	13.16	692 **1,142**	0.590	17,630	4.34	423 **716**
	July 30, 1892	15.3	0.731	60	3.04	3.26	12,550 **12,700**	8,960 **9,060**	1,590,000 **1,599,900**	3.04 **3.13**	8.1	9.88	7,530 **7,609**	2.99	13.01	1,272 **1,289**	0.685	17,820	3.84	813 **822**
10	Nov. 27, 1891	30.6	0.718	60	3.37	3.50	9,720 **13,311**	7,614 **10,284**	1,870,000 **2,122,000**	1.92 **3.21**	8.1	11.45	5,900 **8,374**	3.50	12.14	898 **1,408**	0.853	10,080	3.62	485 **823**
	July 30, 1892	16.7	0.696	60	3.28	3.40	*12,130 **12,959**	9,840 **10,380**	1,890,000 **1,941,200**	2.85 **3.24**	8.0	11.35	7,350 **7,790**	3.48	13.32	1,032 **1,123**	0.540	17,740	3.74	882 **931**
11	Nov. 13, 1891	26.8	0.764	60	3.45	3.20	7,640 **10,775**	5,904 **8,214**	1,270,000 **1,476,600**	1.62 **2.76**	8.0	10.84	4,955 **7,843**	3.46	12.60	635 **1,069**	0.488	†‡10,240	4.25	352 **634**
	Aug. 1, 1892	13.5	0.751	60	3.18	3.47	12,030 **11,020**	8,980 **8,210**	1,740,000 **1,632,000**	2.98 **2.34**	8.0	10.90	6,930 **6,425**	3.44	12.77	1,084 **971**	0.715	18,830	3.96	815 **773**
12	Dec. 2, 1891	27.1	0.739	60	3.37	3.48	9,570 **12,745**	9,297 **11,637**	1,580,000 **1,690,200**	2.79 **3.94**	8.0	11.34	5,670 **7,791**	3.49	12.11	760 **1,201**	0.875	14,400	4.80	516 **803**
	Aug. 1, 1892	15.1	0.741	60	3.47	3.22	13,000 **13,050**	9,470 **9,500**	1,610,000 **1,613,300**	2.74 **2.77**	8.0	11.35	6,880 **6,907**	3.47	13.17	1,438 **1,444**	0.732	18,420	3.79	858 **860**

* Wind shaken. † Knot. ‡ Failed by shearing.

[Species: *Pinus palustris*. Habitat: Wilson, Ala.; good pine land; well timbered. **TREE No. 56**; cut October, 1891; sawed November, 1891.]

LOG DIAGRAM:





Log 1.

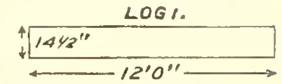
2	Nov. 20, 1891	24.5	0.796	60	3.35	3.43	10,750 **13,560**	7,292 **9,342**	1,630,000 **1,808,500**	2.11 **3.14**	8.4	11.39	5,760 **7,585**	3.40	12.70	1,024 **1,402**	0.661	17,990	3.89	528 **873**
	July 30, 1892	17.5	0.852	60	3.09	3.10	14,320 **15,480**	10,090 **10,850**	2,300,000 **2,369,500**	2.85 **3.36**	8.0	9.06	8,350 **8,978**	2.96	11.55	1,199 **1,328**	0.670	18,670	3.56	1,029 **1,119**
4	Nov. 24, 1891	26.8	0.757	59.5	2.86	3.70	10,260 **13,395**	7,488 **9,798**	1,890,000 **2,096,600**	1.87 **3.01**	8.0	11.06	6,000 **8,888**	3.80	11.08	596 **1,030**	0.651	18,600	4.03	578 **1,007**
	July 30, 1892	17.4	0.824	60	3.47	2.86	11,250 **12,372**	9,930 **10,660**	2,080,000 **2,147,400**	2.82 **3.33**	8.0	9.41	7,810 **8,415**	3.46	10.81	1,107 **1,231**	0.637	22,260	4.04	874 **960**
6	Dec. 3, 1891	24.6	0.774	60	3.03	3.56	10,700 **13,525**	6,717 **8,777**	1,850,000 **2,029,800**	2.12 **3.15**	8.2	10.98	5,710 **7,547**	3.00	13.36	1,033 **1,413**	0.753	12,350	4.52	462 **811**
	Aug. 1, 1892	15.5	0.770	60	3.42	2.87	*14,320 **14,570**	8,390 **9,560**	1,930,000 **1,946,500**	2.90 **3.05**	7.5	9.96	8,300 **8,433**	3.36	11.59	880 **908**	0.700	22,310	3.95	836 **853**
8	Dec. 3, 1891	25.6	0.765	60	3.24	3.39	10,590 **13,561**	7,584 **9,764**	1,920,000 **2,112,200**	1.84 **2.92**	8.3	11.34	5,740 **7,694**	3.43	11.92	822 **1,228**	0.800	18,750	4.43	508 **892**
	Aug. 1, 1892	15.5	0.759	60	3.17	3.04	14,430 **14,680**	10,070 **10,240**	2,120,000 **2,136,500**	3.03 **3.18**	7.4	8.70	7,700 **7,833**	2.91	11.32	1,149 **1,177**	0.563	15,090	3.42	1,080 **1,103**

* Wind shaken.

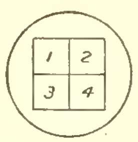
TABLE I.—Condensed Results of Individual Tests on Long-leaf Yellow Pine—Continued.

[Reduced results at 15 per cent moisture given in bold-faced type.]

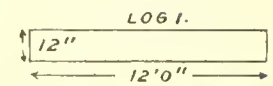
LOG DIAGRAM:



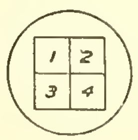
[Species: *Pinus palustris*. Habitat: Wilson, Ala.; good pine land; partially exposed. **TREE No. 57**; cut October, 1891; sawed November, 1891.]

Log number and method of cutting.	No. of stick.	Date of test.	Per-cent-age of mois-ture.	Spe-cific grav-ity.	Cross-bending tests. Dimensions. l.	h.	b.	Modulus of ultimate strength. $=\frac{3Wl}{2bh^2}$	Modulus of strength at the elastic limit per square inch. $f=\frac{3W_1l}{2bh^2}$	Modulus of elasticity.	Relative elastic resilience in inch-pounds per cub. inch.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean)	Strength (mean) per square inch.
					In.	*In.*	*In.*	*Pounds.*				*In.*	*Sq. in.*	*Pounds.*	*in.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*
 Log 1.	1	Nov. 27, 1891	28.3	0.713	60	3.66	3.70	10,250 **13,575**	7,272 **9,732**	1,670,000 **1,894,600**	2.01 **3.21**	8.0	1.31	5,430 **7,682**	3.63	13.36	674 **1,140**	0.800	13,000	4.01	504 **809**
	1	Aug. 1, 1892	14.6	0.754	60	3.46	3.49	14,000 **13,744**	9,910 **9,750**	1,720,000 **1,696,800**	3.56 **3.40**	8.1	12.08	7,680 **7,808**	3.47	13.75	1,616 **1,588**	0.650	17,580	3.96	1,094 **1,084**
	2	Nov. 27, 1891	28.0	0.747	60	3.34	3.53	10,120 **13,409**	7,219 **9,616**	1,770,000 **1,991,000**	1.82 **3.01**	9.0	11.62	5,340 **7,560**	3.50	12.18	755 **1,215**	0.775	13,160	3.71	681 **982**
	2	Aug. 1, 1892	13.6	0.743	60	3.51	3.49	13,920 **12,984**	11,410 **10,710**	1,970,000 **1,872,000**	3.97 **3.38**	8.1	12.11	8,060 **7,592**	3.48	13.75	1,283 **1,387**	0.675	17,440	3.88	1,139 **1,100**
	3	Nov. 27, 1891	29.3	0.752	60	3.63	3.61	9,250 **12,695**	6,810 **9,360**	1,560,000 **1,796,600**	1.87 **3.11**	8.9	13.21	4,950 **7,304**	3.66	13.28	994 **1,480**	0.878	12,460	4.01	578 **898**
	3	Aug. 1, 1892	14.2	0.781	60	3.45	3.48	13,620 **13,108**	9,780 **9,460**	1,780,000 **1,733,600**	3.47 **3.14**	8.1	12.04	7,576 **7,314**	3.46	13.75	1,301 **1,246**	0.725	13,700	3.90	802 **774**
	4	Nov. 27, 1891	31.5	0.722	60	3.35	3.60	8,910 **12,600**	6,594 **9,344**	1,600,000 **1,861,000**	1.87 **3.19**	9.0	12.25	4,910 **7,465**	3.75	12.03	831 **1,358**	0.800	14,000	3.44	549 **897**
	4	Aug. 1, 1892	15.1	0.763	60	3.20	3.40	12,490 **12,540**	9,780 **9,810**	1,790,000 **1,793,300**	3.52 **3.55**	8.1	11.04	7,660 **7,687**	3.24	13.75	1,164 **1,170**	0.638	18,630	3.82	912 **915**

LOG DIAGRAM:

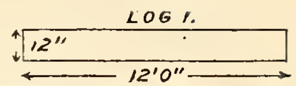


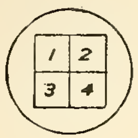
[Species: *Pinus palustris*. Habitat: Wilson, Ala.; good pine land; well timbered. **TREE No. 58**; cut October, 1891; sawed November, 1891.]

Log number and method of cutting.	No. of stick.	Date of test.	Per-cent-age of mois-ture.	Spe-cific grav-ity.	l.	h.	b.	Modulus of ultimate strength.	Modulus of strength at the elastic limit.	Modulus of elasticity.	Relative elastic resilience.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean)	Strength (mean) per square inch.
 Log 1.	1	Dec. 3, 1891	35.8	0.791	60	3.18	3.24	10,060 **14,166**	7,384 **10,454**	1,810,000 **2,114,000**	1.54 **2.98**	8.0	10.65	5,010 **7,915**	3.30	11.78	662 **1,258**	0.828	11,830	3.73	633 **1,023**
	1	Aug. 9, 1892	14.9	0.757	60	3.49	3.30	10,960 **10,896**	8,960 **8,920**	2,000,000 **1,994,200**	2.49 **2.45**	8.0	11.52	7,550 **7,518**	3.50	12.97	1,199 **1,192**	0.713	17,400	3.93	1,040 **1,037**
	2	Nov. 27, 1891	34.8	0.812	60	3.00	3.22	8,120 **12,131**	5,898 **8,898**	1,740,000 **2,034,000**	1.37 **2.78**	9.1	9.30	4,900 **7,729**	3.28	9.83	529 **1,110**	0.800	17,500	4.22	527 **909**
	2	Aug. 9, 1892	14.9	0.796	60	3.18	2.95	11,220 **11,156**	8,690 **8,650**	1,940,000 **1,934,200**	2.58 **2.54**	8.1	9.20	7,940 **7,908**	3.18	11.40	1,302 **1,295**	0.600	23,000	3.49	921 **918**
	3	Nov. 24, 1891	28.2	0.748	59.5	3.56	3.70	9,490 **12,803**	7,227 **9,687**	1,650,000 **1,873,400**	1.88 **3.08**	8.2	13.39	5,710 **7,951**	3.71	13.47	869 **1,333**	0.640	26,260	4.16	482 **786**
	3	Aug. 10, 1892	15.3	0.745	60	3.39	3.50	12,850 **13,000**	9,400 **9,500**	1,900,000 **1,909,900**	3.03 **3.12**	8.0	11.83	7,700 **7,779**	3.49	13.13	1,316 **1,333**	0.650	21,280	3.89	781 **790**
	4	Nov. 24, 1891	28.2	0.739	59.5	3.25	3.78	9,300 **12,613**	7,151 **9,601**	1,580,000 **1,803,400**	1.97 **3.17**	8.2	12.17	5,490 **7,731**	3.75	11.92	814 **1,278**	0.559	22,900	3.89	720 **1,024**
	4	Aug. 10, 1892	17.5	0.753	60	3.39	3.00	13,150 **14,310**	9,920 **10,680**	1,940,000 **2,009,500**	3.31 **3.82**	8.0	9.91	7,910 **8,538**	3.38	11.51	1,268 **1,397**	0.672	11,280	3.77	820 **891**

[Species: *Pinus palustris*. Habitat: Wilson, Ala.; good pine land; well timbered. **TREE No. 59**; cut October, 1891; sawed November, 1891.]

LOG DIAGRAM:



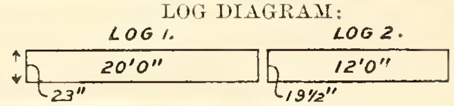


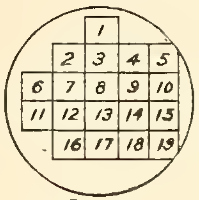
Log 1.

1	Nov. 27, 1891	32.4	0.850	60	3.03	3.32	12,290 **16,070**	8,860 **11,680**	2,280,000 **2,327,680**	2.47 **3.81**	8.9	9.87	5,030 **7,664**	3.30	10.97	1,003 **1,546**	0.700	21,430	3.88	618 **1,249**
1	Aug. 10, 1892	18.5	0.984	60	3.45	3.00	14,690 **16,200**	9,580 **10,580**	2,100,000 **2,109,590**	2.72 **3.34**	8.0	10.22	9,010 **9,850**	3.43	11.71	1,920 **2,094**	0.747	15,460	3.84	917 **1,044**
3	Nov. 20, 1891	25.7	0.870	60	3.22	3.56	7,190 **10,175**	7,020 **9,210**	1,700,000 **1,729,320**	1.57 **2.66**	8.0	11.31	5,690 **7,656**	3.20	11.84	1,098 **1,507**	0.436	18,130	3.78	712 **1,200**
3	Aug. 10, 1892	17.0	0.949	60	3.47	3.29	10,450 **11,420**	7,270 **7,900**	1,610,000 **1,615,480**	2.16 **2.58**	8.0	8.45	7.790 **7,275**	3.11	12.06	1,591 **1,697**	0.625	11,520	3.68	980 **1,052**
4	Nov. 27, 1891	31.7	0.825	60	3.26	3.48	9,030 **12,740**	6,328 **9,088**	1,970,000 **2,015,760**	1.34 **2.66**	9.0	10.82	6,560 **9,133**	3.56	11.92	788 **1,319**	0.675	24,450	3.52	497 **1,103**
4	Aug. 10, 1892	16.6	0.786	60	3.14	3.16	12,130 **12,912**	9,820 **10,330**	2,150,000 **2,154,380**	2.84 **3.21**	8.1	9.92	8,200 **8,590**	3.13	12.50	1,106 **1,192**	0.803	18,430	3.68	1,182 **1,239**

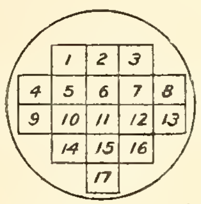
[Species: *Pinus palustris*. Habitat: Wilson, Ala.; on gravelly ridge, partially exposed. **TREE No. 60**; cut October, 1891; sawed November, 1891; age 225 years.]

LOG DIAGRAM:





Log. 1.



Log. 2.

3	Nov. 17, 1891	28.1	0.739	60	3.48	3.48	8,990 **12,291**	7,346 **9,786**	1,660,000 **1,882,200**	2.00 **3.19**	8.2	12.01	5,980 **8,211**	3.47	13.80	1,261 **1,723**	0.627	16,120	4.09	578 **881**
3	Aug. 2, 1892	16.2	0.824	53	3.19	3.25	10,500 **11,094**	10,090 **10,490**	1,900,000 **1,938,200**	3.49 **3.78**	8.1	10.21	7,290 **7,605**	3.22	12.61	1,122 **1,188**	0.722	16,160	3.80	848 **883**
3	Jan. 6, 1892	18.8	0.712	60	3.35	3.24	11,760 **13,366**	9,806 **10,876**	1,751,000 **1,845,400**	3.01 **3.66**	7.8	10.72	7,390 **8,290**	3.25	11.92	1,837 **2,023**	0.610	12,300	3.96	530 **638**
7	Dec. 7, 1891	31.0	0.696	60	3.42	3.58	10,440 **14,075**	8,164 **10,864**	1,810,000 **2,066,000**	2.25 **3.55**	8.3	12.41	4,800 **7,310**	3.40	13.36	808 **1,326**	0.514	21,190	3.97	734 **1,077**
14	Nov. 17, 1891	28.2	1.039	60	3.50	3.53	10,930 **14,243**	8,328 **10,788**	1,780,000 **2,003,400**	2.41 **3.61**	8.0	12.07	5,910 **8,151**	3.44	13.92	999 **1,463**	0.492	14,630	4.32	504 **808**
14	Aug. 2, 1892	15.2	0.786	53	3.36	3.04	13,300 **13,400**	11,470 **11,540**	2,070,000 **2,076,600**	3.84 **3.90**	8.0	10.25	9,250 **9,303**	3.33	12.18	1,059 **1,070**	0.741	14,130	3.64	9.38 **944**
14	Jan. 7, 1892	17.7	0.726	60	3.35	3.47	12,670 **13,906**	10,260 **11,070**	1,862,000 **1,935,700**	3.43 **3.96**	7.9	11.76	6,920 **7,593**	3.39	12.73	1,453 **1,591**	0.784	16,580	......	......
15	Nov. 17, 1891	30.5	0.805	60	3.37	3.56	8,860 **12,440**	6,234 **8,894**	1,490,000 **1,741,000**	1.63 **2.92**	8.0	12.16	4,727 **7,192**	3.46	14.16	1,031 **1,540**	0.573	11,000	4.22	426 **763**
15	Jan. 6, 1892	17.8	0.674	60	3.15	3.42	11,760 **13,034**	9,238 **10,078**	1,756,000 **1,831,800**	3.01 **3.55**	7.9	11.01	69.90 **7,685**	3.41	11.85	1,122 **1,265**	0.835	18,200	3.81	642 **720**
16	Nov. 17, 1891	29.9	0.728	60	3.46	3.75	10,200 **13,714**	7,183 **9,783**	1,880,000 **2,123,800**	1.62 **2.89**	8.4	12.73	5,450 **7,861**	3.66	13.72	598 **1,095**	0.678	17,120	4.18	622 **952**
16	Aug. 2, 1892	16.6	0.725	52	3.66	3.30	10,340 **11,122**	6,640 **7,150**	1,560,000 **1,608,600**	1.96 **2.33**	8.1	12.82	6,410 **6,825**	3.34	14.34	1,079 **1,165**	0.688	16,060	4.08	776 **821**
16	Jan. 6, 1892	18.1	0.762	60	3.17	3.63	12,630 **14,012**	9,394 **10,304**	1,775,000 **1,856,800**	2.98 **3.56**	7.9	11.35	7,300 **8,060**	3.66	11.30	1,080 **1,236**	0.885	16,940	4.50	678 **766**
17	Nov. 17, 1891	29.7	0.743	60	3.57	3.74	8,330 **11,821**	6,800 **9,390**	1,630,000 **1,871,400**	1.84 **3.10**	8.0	13.10	4,955 **7,347**	3.70	14.12	623 **1,116**	0.591	17,590	4.34	543 **869**
17	Aug. 2, 1892	15.7	0.812	45	3.64	3.44	12,590 **12,940**	9,850 **10,090**	1,980,000 **2,000,100**	3.19 **3.38**	8.1	12.59	7,460 **7,646**	3.69	13.68	1,226 **1,265**	0.647	18,800	3.73	828 **848**
17	Jan. 7, 1892	18.7	0.728	60	3.36	3.64	13,140 **14,714**	10,070 **11,120**	1,790,000 **1,882,600**	3.22 **3.86**	7.9	12.26	6,950 **7,830**	3.64	12.26	962 **1,144**	0.787	15,240	4.50	602 **707**
2	Nov. 20, 1891	31.7	0.678	60	3.32	3.43	7,310 **11,020**	5,620 **8,380**	1,400,000 **1,663,000**	1.43 **2.75**	8.0	11.38	4,430 **7,003**	3.51	12.96	540 **1,071**	0.585	14,350	4.28	472 **823**
2	Aug. 10, 1892	15.5	0.587	60	3.26	3.10	9,590 **9,840**	8,200 **8,370**	1,810,000 **1,826,500**	2.38 **2.53**	8.1	10.11	6,080 **6,213**	3.11	12.81	1,275 **1,303**	0.715	16,780	3.78	672 **687**
7	Nov. 24, 1891	24.7	0.660	59.5	3.23	3.39	8,180 **11,020**	6,405 **8,475**	1,400,000 **1,581,100**	1.73 **2.77**	8.3	11.08	5,040 **6,889**	3.46	12.03	648 **1,031**	0.330	16,650	3.94	582 **829**
7	Aug. 10, 1892	15.2	0.654	60	3.19	3.22	11,540 **11,640**	8,790 **8,860**	1,860,000 **1,866,600**	2.47 **2.53**	8.0	10.24	7,060 **7,113**	3.21	12.61	1,018 **1,029**	0.753	9,560	3.31	926 **932**
9	Dec. 4, 1891	33.5	0.688	60	3.42	3.74	8,150 **12,040**	6,574 **9,484**	1,570,000 **1,852,000**	1.77 **3.15**	8.0	12.25	4,280 **7,005**	3.75	12.44	900 **1,461**	0.825	16,610	4.23	512 **882**
9	Aug. 10, 1892	15.5	0.578	60	3.26	3.31	8,960 **9,210**	7,940 **8,110**	1,510,000 **1,526,500**	2.43 **2.58**	8.1	10.79	6,340 **6,473**	3.30	12.93	1464 **1,492**	0.625	13,020	3.70	831 **846**

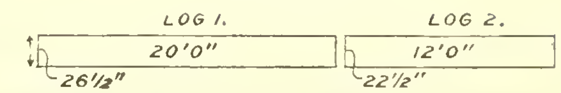
TABLE I.—Condensed Results of Individual Tests on Long-leaf Yellow Pine—Continued.

[Reduced results at 15 per cent moisture given in bold-faced type.]

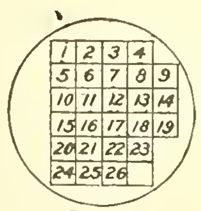
TREE No. 60—Continued.

Log number and method of cutting.	No. of stick.	Date of test.	Per-centage of moisture.	Specific gravity.	Cross-bending tests. Dimensions. l.	h.	b.	Modulus of ultimate strength. $f=\frac{3\ W\ l}{2\ b\ h^2}$	Modulus of strength at the elastic limit, per square inch. $f=\frac{3\ W_1\ l}{2\ b\ h^2}$	Modulus of elasticity.	Relative elastic resilience in inch-pounds per cub. inch.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean)	Strength (mean) per square inch.
					In.	In.	In.	Pounds.				In.	Sq. in.	Pounds.	In.	Sq. in.	Pounds.	Sq. in.	Pounds.	Sq. in.	Pounds.
Log 2—Continued.	15	Nov. 20, 1891	27.9	0.672	60	3.35	3.43	9,400	7,016	1,700,000	1.82	8.0	11.25	4,977	3.42	13.28	723	0.475	19,160	4.23	540
								12,676	**9,436**	**1,919,800**	**3.01**			**7,186**			**1,181**				**840**
	15	Aug. 11, 1892	17.4	0.680	60	3.22	3.19	10,690	8,160	1,930,000	2.13	8.1	10.05	6,890	3.12	12.61	981	0.822	20,200	3.78	876
								11,812	**8,890**	**1,997,400**	**2.63**			**7,495**			**1,105**				**7**

LOG DIAGRAM:



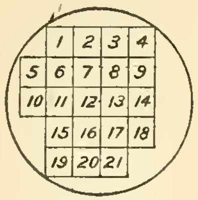
[Species: *Pinus palustris*. Habitat:—Wilson, Ala.; slightly graveled; well sheltered. **TREE No. 61**; cut October, 1891; sawed November, 1891; age, 214 years.]



Log. 1.

Log number and method of cutting.	No. of stick.	Date of test.	Per-centage of moisture.	Specific gravity.	l.	h.	b.	Modulus of ultimate strength.	Modulus of strength at the elastic limit.	Modulus of elasticity.	Relative elastic resilience.	Crushing endwise Height.	Area.	Strength per square inch.	Crushing across grain Height.	Area.	Strength per square inch.	Tension Area.	Strength per square inch.	Shearing Area (mean)	Strength (mean) per square inch.
	10	Nov. 18, 1891	30.0	0.766	60	3.31	3.76	10,040	7,080	1,740,000	1.75	8.2	11.88	4,800	3.68	12.80	617	0.656	25,300	4.07	605
								13,565	**9,690**	**1,985,000**	**3.02**			**7,220**			**1,116**				**935**
	10	Aug. 3, 1892	16.0	0.867	54	3.19	3.51	10,480	8,170	1,900,000	2.27	8.1	11.55	6,990	3.55	12.85	1,194	0.729	24,150	3.95	1,152
								10,980	**8,510**	**1,933,000**	**2.52**			**7,255**			**1,250**				**1,181**
	10	Jan. 6, 1892	20.2	0.721	60	3.14	3.53	11,960	8,067	1,544,000	2.06	7.9	11.05	6,[illegible]40	3.54	11.56	1,246	0.860	19,070	4.23	627
								13,956	**9,437**	**1,662,200**	**2.83**			**7,906**			**1,488**				**774**
	11	Nov. 17, 1891	28.3	0.810	60	3.24	3.60	9,100	7,147	1,630,000	1.84	8.3	11.30	5,660	3.59	12.44	675	0.682	13,200	4.10	596
								12,425	**9,607**	**1,854,600**	**3.04**			**7,912**			**1,141**				**900**
	11	Jan. 6, 1892	18.7	0.821	60	3.20	3.59	11,710	8,519	1,595,000	2.45	7.9	11.55	6,770	3.62	11.78	1,019	0.961	13,730	4.42	814
								13,284	**9,565**	**1,687,600**	**3.09**			**7,650**			**1,201**				**919**
	13	Nov. 18, 1891	28.1	0.760	60	3.32	3.37	10,270	7,755	1,750,000	2.13	8.3	10.96	5,258	3.35	12.96	548	0.661	21,770	4.13	632
								13,571	**10,195**	**1,972,200**	**3.32**			**7,489**			**1,010**				**935**
	13	Aug. 29, 1892	15.7	0.824	44	3.20	3.22	13,150	9,570	2,100,000	2.87	8.1	10.33	8,040	3.26	12.85	1,163	0.753	21,320	3.47	1,034
								13,500	**9,810**	**2,123,100**	**3.06**			**8,226**			**1,202**				**1,054**
	13	Jan. 6, 1892	19.2	0.701	60	3.21	3.23	11,790	8,437	1,579,000	2.21	7.9	10.37	7,080	3.25	11.85	970	0.860	19,080	3.63	798
								13,516	**9,597**	**1,680,400**	**2.90**			**8,058**			**1,173**				**919**
	15	Nov. 17, 1891	30.4	0.764	60	3.44	3.69	88,860	6,234	1,690,000	1.80	8.2	12.44	4,805	3.65	13.60	840	0.708	15,670	(4.21)	511
								12,429	**8,884**	**1,939,800**	**3.08**			**7,261**			**1,347**				**846**
	15	Aug. 3, 1892	18.3	0.873	54	3.35	3.74	13,820	9,460	1,990,000	2.90	8.1	12.04	7,080	3.23	14.42	1,788	0.678	21,540	(4.17)	1,026
								15,266	**10,420**	**2,075,400**	**3.50**			**7,880**			**1,953**				**1,120**
	15	Jan. 6, 1892	20.0	0.717	60	3.32	3.76	12,940	9,900	1,797,000	3.44	7.9	12.48	6,390	3.78	12.22	982	0.756	17,200	4.52	586
								14,890	**11,230**	**1,912,000**	**4.20**			**7,520**			**1,217**				**712**
	16	Nov. 16, 1891	27.9	0.806	60	3.48	3.68	10,260	7,270	1,640,000	1.95	8.3	12.44	4,936	3.70	13.40	657	0.498	18,480	4.18	498
								13,536	**9,690**	**1,859,800**	**3.14**			**7,145**			**1,115**				**797**
	16	Aug. 17, 1892	15.6	0.902	53	3.28	3.14	13,520	11,190	2,210,000	3.45	8.1	10.52	8,630	3.36	12.57	1,181	0.609	27,870	3.02	876
								13,820	**11,390**	**2,229,800**	**3.62**			**8,789**			**1,215**				**892**
	16	Jan. 7, 1892	20.5	0.744	60	3.31	3.46	13,800	10,720	1,926,000	3.47	7.9	11.62	*6,970	3.45	12.33	989	0.828	17,260	4.14	640
								15,865	**12,140**	**2,049,000**	**4.27**			**8,190**			**1,242**				**795**
	20	Nov. 16, 1891	41.4	0.870	60	3.45	3.49	7,190	4,981	1,360,000	1.15	8.4	11.02	3,829	3.29	13.16	494	0.813	13,540	4.32	654
								11,828	**8,391**	**1,720,000**	**2.70**			**7,108**			**1,166**				**1,074**
	20	Jan. 6, 1892	22.1	0.650	60	3.40	3.70	10,560	7,994	1,708,000	2.27	7.9	12.72	5,500	3.71	12.51	704	0.991	15,550	4.28	914
								12,969	**9,704**	**1,854,400**	**3.17**			**6,990**			**1,011**				**1,108**

21	Nov. 18, 1891	31.5	0.760	60	3.61	3.70	9,200	6,657	1,660,000	1.56	8.3	13.21	4,800	3.69	14.40	639	0.798	16,160	4.41	635
							12,890	**9,407**	**1,921,000**	**2.88**			**7,355**			**1,166**				**983**
	Aug. 3, 1892	17.3	0.879	53	3.46	3.43	13,150	9,300	1.890.000	2.91	8.1	11.63	7.370	3.40	13.44	1,729	0.642	23,050	3.80	1,047
							14,234	**10,010**	**1,955,300**	**3.39**			**7,953**			**1,849**				**112**
21	Jan. 7, 1892	20.3	0.721	60	3.49	3.54	10,720	8,590	1,286,000	2.77	7.9	12.35	6,480	3.58	12.73	1,202	0.885	18,300	4.32	808
							12,739	**9,980**	**1,405,800**	**3.55**			**7,664**			**1,448**				**958**
23	Dec. 7, 1891	29.6	0.752	60	3.51	3.51	8,430	6,662	1,650,000	1.66	8.3	12.21	4,910	3.55	12.59	747	0.666	19,380	4.55	614
							11,909	**9,242**	**1,890,200**	**2.91**			**7,292**			**1,238**				**937**
	Aug. 4, 1892	17.0	0.851	60	3.51	3.48	12,760	9,230	2,010,000	2.63	8.1	12.04	7,210	3.44	13.48	1,227	0.725	17,430	3.98	758
							13,730	**9,860**	**2,069,000**	**3.05**			**7,725**			**1,333**				**815**
26	Aug. 3, 1892	15.5	0.591	53	3.66	3.35	9,350	6,380	1,500,000	1.65	8.1	12.08	5,110	3.65	13.13	904	0.692	15,910	3.94	875
							9,600	**6,550**	**1,516,500**	**1.80**			**5,243**			**1,102**				**890**
2	Nov. 24, 1891	28.6	0.733	59.5	3.34	3.62	8,460	6,131	1,550,000	1.92	8.4	11.29	5,030	3.52	11.70	684	0.627	15,220	4.08	502
							11,822	**8,621**	**1,778,200**	**3.73**			**7,313**			**1,156**				**812**
	Aug. 11, 1892	18.5	0.717	60	3.22	3.08	9,980	8,460	1,840,000	2.39	7.9	9.82	6,580	3.05	12.57	1,592	0.688	18,690	3.59	910
							11,490	**9,460**	**1,929,000**	**3.01**			**7,420**			**1,766**				**1,010**
11	Nov. 24, 1891	25.1	0.734	59.5	2.86	3.22	9,450	6,812	1,480,000	2.44	8.1	8.82	5,900	3.19	9.79	725	0.408	15,680	4.24	599
							12,349	**8,932**	**1,666,200**	**3.50**			**7,797**			**1,119**				**853**
	Aug. 11, 1892	16.2	0.607	60	2.93	2.49	11,030	8,420	1,810,000	2.72	7.9	7.29	6,930	2.96	9.75	960	0.612	20,240	3.59	746
							11,624	**8,820**	**1,848,200**	**3.01**			**7,245**			**1,026**				**781**
14	Nov. 24, 1891	29.1	0.701	59.5	2.87	3.59	8,750	7,000	1,460,000	1.69	8.0	9.80	5,000	3.51	9.97	752	0.607	14,160	3.81	592
							12,172	**9,530**	**1,694,200**	**2.92**			**7,335**			**1,234**				**909**
	Aug. 11, 1892	16.6	0.711	60	3.10	2.67	9,120	7,300	1,560,000	2.17	8.0	8.15	6,610	3.09	10.26	1,161	0.693	11,690	3.51	750
							9,902	**7,810**	**1,608,600**	**2.54**			**7,025**			**1,247**				**796**
20	Dec. 2, 1891	34.6	0.696	60	3.25	3.45	6,450	6,128	1,140,000	1.76	8.0	10.60	3,460	3.13	12.55	669	0.872	11,700	4.41	376
							10,442	**9,108**	**1,432,000**	**3.17**			**6,273**			**1,247**				**756**
	Aug. 11, 1892	16.4	0.596	60	3.22	3.17	9,720	7,500	1,380,000	2.55	8.0	10.18	6,230	3.19	12.61	1,177	0.685	10,510	3.64	652
							10,408	**7,960**	**1,423,400**	**2.88**			**6,595**			**1,253**				**692**
1	Sept. 8, 1892	13.0	0.613	60	3.47	3.23	10,510	8,800	1,480,000	2.68	8.0	5.68	5,880	3.48	12.73	1,025	0.628	12,400	4.01	609
							9,130	**7,650**	**1,322,000**	**1.79**			**5,190**			**868**				**774**
	Oct. 21, 1892	12.8	0.642	60	3.29	3.37	12,930	9,623	1,890,000	3.01	8.0	11.19	8,240	3.37	13.20	1,056	0.618	9,070	3.57	914
							11,406	**8,213**	**1,704,800**	**2.04**			**7,456**			**875**				**1,095**
3	Sept. 5, 1892	13.8	0.687	60	3.26	3.19	12,610	7,593	1,760,000	3.41	8.0	8.94	7,340	3.30	12.50	1,265	0.573	16,060	3.44	833
							11,822	**7,043**	**1,682,000**	**2.90**			**6,946**			**1,178**				**932**
	Oct. 19, 1892	12.3	0.708	60	3.12	3.00	13,220	11,400	1,997,000	3.92	8.0	9.11	9,060	2.92	12.26	1,982	0.838	18,390	3.53	665
							11,336	**9,340**	**1,743,800**	**2.72**			**8,041**			**1,741**				**888**
7	Sept. 5, 1892	13.2	0.695	60	3.35	3.15	13,920	10,690	1,910,000	3.71	8.0	10.55	8,140	3.35	12.50	968	0.608	10,550	3.36	792
							12,688	**9,690**	**1,772,000**	**2.92**			**7,524**			**829**				**941**
	Oct. 20, 1892	11.7	0.688	60	3.07	3.03	9,460	9,113	2,125,000	2.23	8.0	9.33	9,210	3.06	11.95	1,155	0.627	14,100	3.55	744
							7,135	**6,273**	**1,790,200**	**0.76**			**7,882**			**835**				**1,017**
8	Sept. 6, 1892	12.9	0.704	60	3.24	3.30	10,940	8.580	1,590,000	2.77	8.0	10.56	7,400	3.22	12.93	1,224	0.523	13,430	3.89	931
							9,458	**7,300**	**1,418,400**	**1.70**			**6,663**			**1,055**				**1,089**
	Oct. 19, 1892	14.0	0.721	60	3.07	2.97	13.340	11,570	2,294,000	3.85	8.0	9.06	9,420	2.98	11.95	1,264	0.685	14,270	3.57	730
							12,700	**11,170**	**2,236,000**	**3.42**			**9,100**			**1,195**				**807**
10	Sept. 6, 1892	12.5	0.568	60	3.17	2.76	10,380	8,434	1,720,000	2.70	8.0	8.55	6,760	3.11	10.77	961	0.715	15,090	3.66	743
							8,640	**6,634**	**1,494,000**	**1.60**			**5,835**			**744**				**950**
	Oct. 19, 1892	11.4	0.599	60	3.37	2.70	11,390	10,860	1,724,000	4.07	8.0	8.88	7,660	3.34	10.38	1,181	0.806	10,460	3.99	646
							8,840	**7,630**	**1,348,400**	**2.46**			**6,164**			**817**				**942**
15	Sept. 6, 1892	13.7	0.627	60	3.40	2.97	11,790	9,430	1,620,000	3.42	8.0	13.36	5,650	3.40	11.52	898	0.565	15,550	3.88	924
							10,928	**8,810**	**1,532,000**	**2.87**			**5,219**			**803**				**1,031**
	Oct. 20, 1892	11.8	0.645	60	3.20	3.02	13,650	11,760	1,964,000	4.37	8.0	9.63	8,460	3.22	11.71	1,059	0.635	19,500	3.56	548
							11,400	**9,050**	**1,642,800**	**2.94**			**7,188**			**753**				**812**
16	Sept. 8, 1892	13.7	0.685	60	3.32	3.34	12,100	10,220	1,720,000	3.70	8.0	10.89	7,870	3.29	13.01	1,141	0.647	12,620	3.84	729
							11,238	**9,600**	**1,632,000**	**3.15**			**7,439**			**1,046**				**836**
	Oct. 20, 1892	11.7	0.702	60	3.03	2.94	15.240	11,610	2,047,000	4.12	8.0	8.78	8,910	3.04	9.59	1,585	0.613	13,940	3.56	637
							12,915	**8,770**	**1,712,200**	**2.65**			**7,582**			**1,265**				**907**
18	Sept. 8, 1892	14.4	0 528	60	3.58	3.26	9,610	7,330	1,440,000	2.29	8.1	11.64	5,870	3.56	12.85	862	0.784	9,810	3.94	841
							9,226	**7,090**	**1,405,200**	**2.05**			**5,678**			**821**				**891**
	Oct. 18, 1892	13.7	0.598	60	3.22	2.96	10,940	8,800	1,530,000	2.83	8.1	9.52	7,460	3.24	11.63	1,178	0.858	13,530	3.64	664
							10,078	**8,180**	**1,442,000**	**2.28**			**7,029**			**1,083**				**771**
21	Sept. 6, 1892	13.9	0.526	60	3.29	2.50	8,950	6,987	1,180,000	2.51	8.0	8.15	5,310	3.33	9.86	990	0.689	9.710	3.76	773
							8,236	**6,517**	**1,112,000**	**2.04**			**4,953**			**912**				**818**
	Oct. 19, 1892	11.0	0.545	60	3.07	2.82	11,650	8,840	1,588,000	3.26	8.0	7.70	7,190	2.99	10.89	1,571	0.711	9,640	4.00	519
							8,800	**5,090**	**1,158,000**	**1.45**			5,470			**1,149**				**849**



Log 2.

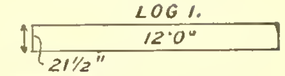
* Knot.

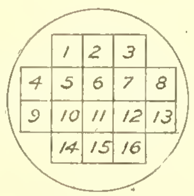
TABLE I.—CONDENSED RESULTS OF INDIVIDUAL TESTS ON LONG-LEAF YELLOW PINE—Continued.

[Reduced results at 15 per cent moisture given in bold-faced type.]

[Species: *Pinus palustris*. Habitat: Wilson, Ala.; gravelly ridge; freely exposed. **TREE No. 62**; cut October, 1891; sawed November, 1891.]

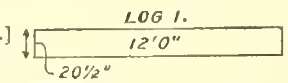
LOG DIAGRAM:

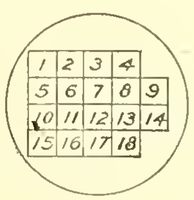


Log number and method of cutting.	No. of stick.	Date of test.	Per centage of moisture.	Specific gravity.	Cross-bending tests. Dimensions. *l.*	*h.*	*b.*	Modulus of ultimate strength. $f=\frac{3}{2}\frac{W\,l}{b\,h^2}$	Modulus of strength at the elastic limit, per square inch. $f=\frac{3}{2}\frac{W_1\,l}{b\,h^2}$	Modulus of elasticity.	Relative elastic resilience in inch-pounds per cub. inch.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean).	Strength (mean) per square inch.
					In.	*In.*	*In.*	*Pounds.*				*In.*	*Sq. in.*	*Pounds.*	*In.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*
	2	Dec. 3, 1891	32.3	0.841	60	3.26	3.62	10,880	8,428	1,850,000	2.33	8.2	11.41	5,470	3.26	12.99	1,409	0.828	17,270	3.77	426
								14,650	**11,238**	**2,119,000**	**3.67**			**8,096**			**1,950**				**782**
		Aug. 4, 1892	15.7	0.830	60	3.47	3.35	11,780	9,870	2,080,000	2.62	8.0	11.97	6,470	3.46	13.60	1,161	0.738	17,190	3.96	814
								12,130	**10,110**	**2,103,100**	**2.81**			**6,656**			**1,200**				**834**
	10	Dec. 2, 1891	24.8	0.796	60	3.35	3.72	11,980	9,487	2,040,000	2.79	8.1	12.03	6,930	3.73	11.96	1,028	0.832	11,780	4.45	483
								14,835	**11,577**	**2,222,400**	**3.83**			**8,791**			**1,414**				**747**
		Aug. 3, 1892	16.2	0.828	60	3.48	3.51	15,030	12,380	2,040,000	4.67	8.1	12.14	8,020	3.48	13.75	1,696	0.744	18,760	3.96	797
								15,624	**12,780**	**2,078,200**	**4.96**			**8,335**			**1,762**				**832**
	15	Dec. 3, 1891	30.7	0.799	60	3.26	3.73	10,220	7,722	1,940,000	1.82	8.3	12.05	4,370	3.71	11.89	648	0.810	21,740	4.11	504
								13,822	**10,392**	**2,193,000**	**3.11**			**6,853**			**1,160**				**843**
Log 1.		Aug. 4, 1892	14.2	0.805	60	3.47	3.24	11,420	10,150	2,030,000	2.94	8.0	11.45	7,580	3.49	13.28	1,437	0.640	27,730	3.95	764
								10,908	**9,830**	**1,983,600**	**2.61**			**7,324**			**1,382**				**742**

[Species: *Pinus palustris*. Habitat: Wilson, Ala.; slightly gravelly ridge; partially exposed. **TREE No. 63**; cut October, 1891; sawed November, 1891; age, 200 years.]

LOG DIAGRAM:

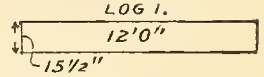


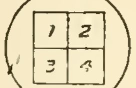
Log number and method of cutting.	No. of stick.	Date of test.	Per centage of moisture.	Specific gravity.	*l.*	*h.*	*b.*	Modulus of ultimate strength.	Modulus of strength at the elastic limit.	Modulus of elasticity.	Relative elastic resilience.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean).	Strength (mean) per square inch.
	3	Nov. 27, 1891	29.1	0.727	60	3.24	3.68	9,790	7,444	1,610,000	2.14	8.0	11.55	5,630	3.59	11.70	649	0.800	15,130	3.56	394
								13,212	**9,974**	**1,874,200**	**3.37**			**7,965**			**1,131**				**711**
		Aug. 4, 1892	14.9	0.833	60	3.47	3.19	12,180	8,900	1,700,600	3.13	8.0	10.96	7,640	3.47	12.69	1,481	0.647	8,960	4.11	776
								12,116	**8,860**	**1,691,200**	**3.09**			**7,608**			**1,474**				**773**
	5	Dec. 3, 1891	49.4	0.701	60	3.24	3.34	7,320	6,370	1,190,000	1.69	8.0	10.56	3,960	3.31	11.89	555	0.900	15,440	3.91	462
								11,033	**10,160**	**1,630,000**	**3.36**			**7,653**			**1,314**				**907**
		Aug. 4, 1892	15.4	0.677	60	3.48	3.51	8,890	7,[illegible]00	1,570,000	2.24	8.1	12.11	69,000	3.48	13.56	1,398	0.719	10,870	3.97	904
								9,090	**7,440**	**1,583,200**	**2.36**			**7,006**			**1,420**				**916**
	16	Nov. 27, 1891	30.4	0.636	60	3.41	3.68	8,290	6,396	1,370,000	1.89	8.9	12.29	4,410	3.62	12.11	669	0.950	[illegible],470	3.94	552
								11,859	**9,046**	**1,619,800**	**3.48**			**6,896**			**1,176**				**887**
		Aug. 3, 1892	16.0	0.791	60	3.50	3.48	10,980	8,450	1,380,000	3.15	8.1	11.90	6,660	3.49	13.09	1,[illegible]91	0.704	9,770	3.90	758
								11,480	**8,790**	**1,413,000**	**3.40**			**6,925**			**1,117**				**787**
	18	Dec. 2, 1891	32.4	0.769	60	3.33	3.72	7,110	3,565	1,430,000	1.22	8.0	11.30	3,960	3.70	11.96	510	0.615	12,360	4.74	540
								10,890	**6,385**	**1,700,000**	**2.56**			**6,594**			**1,053**				**898**
Log 1.		Aug. 4, 1892	15.4	0.763	60	3.28	3.13	10,160	7,490	1,540,000	2.2[illegible]	8.0	10.24	7,010	3.12	11.20	1,357	0.672	11,450	[illegible].83	824
								10,360	**7,[illegible]**	**1,5[illegible]**	**2.[illegible]**			**7,116**			**1,379**				**836**

[Species: *Pinus palustris*. Habitat: Wilson, Ala.; gravelly ridge, well shelterod. **TREE No. 64**; cut October, 1891; sawed November, 1891.]

LOG DIAGRAM:

LOG 1.





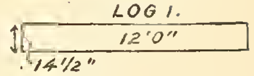
Log 1.

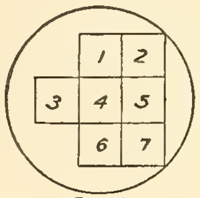
1	Dec. 3, 1891	28.2	0.769	60	3.53	3.61	10,120 **13,433**	8,000 **10,450**	1,970,000 **2,193,400**	1.94 **3.14**	8.0	12.95	5,790 **8,031**	3.55	13.51	866 **1,330**	0.797	15,940	4.52	544 **1,023**
	Aug. 3, 1892	15.2	0.811	60	3.46	3.51	13,070 **13,170**	10,720 **10,790**	2,190,000 **2,196,600**	3.32 **3.38**	8.1	12.11	7,810 **7,863**	3.44	13.75	1,065 **1,076**	0.719	18,910	3.96	952 **959**
2	Dec. 4, 1891	25.9	0.836	57.5	3.44	3.79	10,200 **13,214**	8,000 **10,210**	2,000,000 **2,195,800**	1.88 **2.98**	8.0	12.58	5,960 **7,949**	3.71	12.55	868 **1,282**	0.741	15,650	4.33	582 **976**
	Aug. 4, 1892	16.8	0.837	60	3.48	3.51	12,420 **13,296**	10,120 **10,690**	2,190,000 **2,243,800**	2.74 **3.14**	8.0	12.07	7,920 **8,385**	3.47	13.75	1,261 **1,357**	0 701	15,400	3.99	1,147 **1,212**
3	Nov. 24, 1891	20.5	0.828	59.5	3.42	3.55	10,980 **13,045**	8,595 **10,015**	1,740,000 **1,863,000**	2.71 **3.51**	8.3	12.70	5,890 **7,110**	3.70	12.70	764 **1,017**	0.632	21,680	3.91	470 **669**
	Aug. 3, 1892	15.1	0.910	60	3.46	3.50	11,600 **11,650**	11,090 **11,120**	2,010,000 **2,013,300**	3.50 **3.53**	8.1	12.04	7,920 **7,947**	3.50	13.64	1,514 **1,520**	0.729	14,550	4.06	706 **710**
4	Nov. 24, 1891	26.9	0.816	(59.5)	3.35	3.55	10,480 **13,629**	8,958 **11,278**	1,810,000 **2,017,800**	2.62 **3.77**	8.0	11.32	7,010 **9,109**	3.53	11.63	696 **1,133**	0.450	24,430	4.38	570 **1,002**
	Aug. 11, 1892	17.7	0.874	60	3.31	3.26	13,100 **14,336**	10,880 **11,690**	2,010,000 **2,083,700**	3.57 **4.10**	8.0	10.89	7,490 **8,163**	3.35	12.81	1,285 **1,423**	0.650	18,150	3.72	885 **983**

[Species: *Pinus palustris*. Habitat: Wilson, Ala.; gravelly ridge, slightly sheltered. **TREE No. 65**; cut October, 1891; sawedNovember, 1891.]

LOG DIAGRAM:

LOG 1.





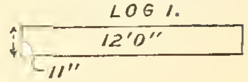
Log 1.

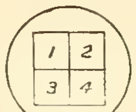
1	Dec. 3, 1891	33.6	0.912	60	3.02	3.26	8,470 **12,369**	6,054 **8,964**	1,840,000	1.22 **2.60**	8.0	9.60	5,650 **8,383**	3.20	11.11	1,134 **1,697**	0.825	18,300	......	......
	Aug. 4, 1892	16.4	0.914	60	3.46	3.14	10,960 **11,648**	9,090 **9,550**	1,950,000	2.59 **2.92**	8.0	10.70	7,790 **8,155**	3.45	12.26	1,338 **1,414**	0.647	19,150	3.97	960 **1,007**
3	Nov. 27, 1891	32.5	0.781	60	3.35	3.68	9,290 **13,080**	6,103 **8,933**	1,950,000	1.26 **2.61**	8.8	12.08	5,050 **7,693**	3.83	11.89	715 **1,260**	0.828	15,340	4.12	422 **1,057**
	Aug. 5, 1892	17.2	0.844	60	3.38	3.25	12,730 **13,776**	10,650 **11,330**	1,980,000	3.50 **3.96**	8.0	10.75	8,340 **8,900**	3.19	13.36	1,237 **1,352**	0.672	21,420	3.77	937 **1,016**
6	Nov. 24, 1891	25.1	0.793	59.5	3.09	3.69	10,210 **13,109**	8,000 **10,120**	1,740,000	2.24 **3.30**	8.0	10.77	6,540 **8,437**	3.65	10.56	701 **1,095**	0.506	23,320	4.01	587 **953**
	Aug. 5, 1892	15.7	0.814	60	3.51	3.19	12,260 **12,610**	9,620 **9,860**	{1,840,000} {1,640,000}	3.11 **3.30**	8.1	11.16	7,270 **7,456**	3.50	12.54	1,311 **1,350**	0.675	19.850	3.82	1,132 **1,157**
7	Nov. 20, 1891	31.3	0.886	60	3.18	3.26	9,660 **13,328**	7,260 **9,990**	1,660,000	1.99 **3.39**	8.0	10.21	5,182 **7,719**	3.00	11.68	548 **1,071**	0.382	20,960	4.27	706 **1,297**
	Aug. 12, 1892	17.4	0.804	60	3.47	3.20	11,350 **12,472**	8.410 **9,140**	1,530,000	2.81 **3.31**	8.2	11.10	6,980 **7,585**	3.48	12.58	1,113 **1,237**	0.719	9,200	3.70	1,029 **1,128**

[Species: *Pinus palustris*. Habitat: Wilson, Ala.; gravelly ridgo. **TREE No. 66**; cut October, 1891; sawed November, 1891; age, 91 years.]

LOG DIAGRAM:

LOG 1.



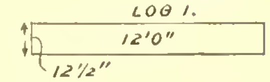


Log. 1.

1	Dec. 2, 1891	31.6	0.858	60	3.55	3.65	10,720 **14,420**	6,650 **9,410**	1,520,000 **1,782,000**	1.80 **3.12**	8.1	12.42	5,100 **7,664**	3.61	13.03	645 **1,174**	0.800	11,870	4.24	512 **1,115**
	Aug. 12, 1892	16.9	0.726	60	3.38	3.36	10,740 **11,663**	7,970 **8,570**	1,540,000 **1,596,400**	2.72 **3.13**	8.1	11.09	6,550 **7,040**	3.36	12.93	1,160 **1,261**	0.781	15,680	3.80	1,039 **1,107**
3	Nov. 24, 1891	29.6	0.790	59.5	3.36	3.18	7,580 **11,059**	6,060 **8,640**	1,440,000 **1,680,200**	1.62 **2.87**	8.4	10.23	5,180 **7,562**	3.30	11.52	694 **1,185**	0.470	13,620	4.06	480 **1,011**
	Aug. 12, 1892	17.4	0.814	60	3.15	3.24	13,660 **14,782**	8,960 **9,690**	2,030,000 **2,097,400**	2.48 **2.98**	8.1	10.27	8,060 **8,665**	3.25	12.77	1,585 **1,709**	0.753	19,490	3.62	1,106 **1,192**

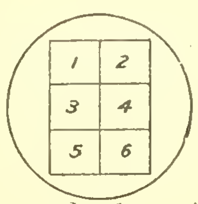
TABLE I.—CONDENSED RESULTS OF INDIVIDUAL TESTS ON LONG-LEAF YELLOW PINE—Continued.

LOG DIAGRAM:



[Reduced results at 15 per cent moisture given in bold-faced type.]

Species: *Pinus palustris*. Habitat: Wilson, Ala.; gravelly ridge. **TREE No. 67**; cut October 1891; sawed November, 1891; age, 116 years.]

Log number and method of cutting.	No. of stick.	Date of test.	Per centage of moisture.	Specific gravity.	Cross-bending tests. Dimensions. l.	h.	b.	Modulus of ultimate strength. $f=\frac{3\,W\,l}{2\,b\,h^2}$	Modulus of strength at the elastic limit, per square inch. $f=\frac{3\,W_1\,l}{2\,b\,h^2}$	Modulus of elasticity.	Relative elastic resilience in inch-pounds per cub. inch.	Crushing endwise. Height.	Area.	Strength per square inch.	Crushing across grain. Height.	Area.	Strength per square inch.	Tension. Area.	Strength per square inch.	Shearing. Area (mean)	Strength (mean) per square inch.
					In.	*In.*	*In.*	*Pounds.*				*In.*	*Sq. in.*	*Pounds.*	*In.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*	*Sq. in.*	*Pounds.*
	3	Nov. 27, 1891	30.0	0.767	60	3.23	3.81	10,550	7,659	1,930,000	1.90	8.0	12.86	6,000	4.09	11.66	563	0.775	22,710	3.90	488
								14,075	**10,269**	**2,175,000**	**3.17**			**8,420**			**1,062**				**1,033**
		Aug. 12, 1892	15.9	0.728	60	3.47	3.23	13,540	12,030	1,960,000	4.27	8.0	10.86	8,280	3.47	12.38	1,115	0.642	13,700	3.64	951
								13,990	**12,340**	**1,989,700**	**4.50**			**8,519**			**1,165**				**983**
	4	Nov. 27, 1891	23.9	0.785	60	3.30	3.57	8,540	8,332	1,870,000	2.38	9.0	11.18	6,160	3.36	11.66	797	0.775	14,970	4.02	648
								11,259	**10,312**	**2,040,700**	**3.38**			**7,911**			**1,158**				**971**
		Aug. 12, 1892	17.0	0.864	60	3.23	3.16	13,590	10,920	2,130,000	3.67	8.1	10.01	8,660	3.21	12.18	1,203	0.707	12,240	3.64	1,095
								14,560	**11,550**	**2,189,000**	**4.09**			**9,175**			**1,309**				**1,167**
	5	Nov. 20, 1891	31.6	0.803	60	3.34	3.64	9,040	5,672	1,870,000	1.12	8.0	11.88	5,680	3.30	12.00	500	0.514	20,220	4.35	640
								12,740	**8,432**	**2,132,000**	**2.44**			**8,244**			**1,029**				**1,243**
		Aug. 12, 1892	15.5	0.713	60	3.40	3.24	11,530	9,730	2,120,000	2.75	8.1	10.76	7,610	3.36	12.81	821	0.645	22,410	3.87	922
								11,780	**9,900**	**2,136,500**	**2.90**			**7,743**			**849**				**940**
	6	Dec. 4, 1891	24.6	0.752	60	3.31	3.84	10,500	8,897	1,820,000	2.60	8.1	12.77	*5,980	3.86	12.07	746	0.825	13,700	4.87	688
								13,325	**10,957**	**1,999,800**	**3.63**			**7,817**			**1,126**				**1,037**
Log. 1.		Aug. 12, 1892	17.0	0.836	60	3.46	3.32	13,860	10,190	2,120,000	3.16	8.1	11.38	8,260	3.44	13.01	1,318	0.580	20,670	3.88	1,049
								14,830	**10,920**	**2,179,000**	**3.58**			**8,775**			**1,427**				**1,121**

*Knot.

TABLE II.—TREE AVERAGES.

AVERAGE RESULTS OF TESTS ON LONG-LEAF YELLOW (OR "GEORGIA") PINE (PINUS PALUSTRIS) (REDUCED TO 15 PER CENT MOISTURE).

[The tabulated values are averages of tests from *individual trees.*]

Local conditions of growth.	Tree. No.	Tree. Age.	Dates of cutting and sawing.	Dates of green and dry tests.	Log diagrams.	Number of sticks tested.	Approximate dimensions (in inches).	Average specific gravity (not reduced for moisture).	Cross-bending tests. Modulus of rupture per square inch. $f=\frac{3\,W\,l}{2\,b\,h}$	Cross-bending tests. Modulus of strength at elastic limit per square inch. $f'=\frac{3\,W'\,l}{2\,b\,h^2}$	Cross-bending tests. Modulus of elasticity. $E=\frac{W\,l^3}{4\Delta b\,h^3}$	Cross-bending tests. Relative elastic resilience in inch-pounds per cubic inch.	Crushing strength endwise per square inch.	Crushing strength across the grain, per square inch. For 3 per cent distortion.	Crushing strength across the grain, per square inch. For 15 per cent distortion.	Tensile strength per square inch (not reduced for moisture).	Shearing strength per square inch.
									Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Wallace, Ala. Upland forest rather dense for the species. Unboxed timber.	1	182	Nov., 1890.	July & Aug., 1891	B 12'4" 5'4" 12'4" 14'4" 19" 16" 15" 14"	19	4×4×60	0.730	12,156	8,833	Small sticks. 1,770,874	2.81	7,096	1,059	1,416	16,439	762
			Feb., 1891.	Aug., 1891	9'4" 9'4" 9'4" T 13" 12" 11"	2	4×8×144	0.703	16,065	11,965	Large sticks. 2,651,700	3.07	8,195	1,200	....	15,090	982
	2	196	Nov., 1890.	July & Aug., 1891	B 12'6" 5'4" 12'4" 14'4" 19" 19" 14" 14"	17	4×4×60	0.715	11,391	8,433	Small sticks. 1,673,675	2.76	6,614	1,023	1,273	12,720	679
			Feb., 1891.	Aug., 1892......	9'4" 9'4" 9'4" T 13" 12" 12"	3	4×8×144	0.720	12,109	10,560	Large sticks. 2,223,853	3.29	7,574	1,001	....	14,746	872
	3	183	Nov., 1890.	July & Aug., 1891	B 12'4" 5'4" 12'4" 17" 15" 14"	12	4×4×60	0.674	11,098	8,823	Small sticks. 1,825,187	2.71	6,464	929	1,137	16,957	629
			Feb., 1891.	Aug., 1892	14'4" 9'4" 9'4" T 13" 12" 11"	2	4×8×144	0.676	14,628	10,520	Large sticks. 3,049,545	2.76	6,960	1,116	....	20,900	759
	4	189	Nov., 1890.	July & Aug., 1891	B 12'4" 5'4" 12'4" 19" 18" 17"	17	4×4×60	0.671	10,505	8,119	Small sticks. 1,568,669	2.64	6,549	974	1,283	15,749	673
			Feb., 1891.	Aug., 1892	14'4" 9'4" 9'4" T 16" 15" 13"	4	4×8×125	0.650	11,763	8,972	Large sticks. 2,234,800	2.71	6,214	1,030	....	16,815	689
	5	226	Nov., 1891 Feb., 1891.	July, 1891	B 5'4" 5'4" 5'4" T 27" 24" 23"	24	4×4×60	0.672	12,796	9,174	Small sticks. 2,197,808	2.60	6,891	1,141	....	19,081	825

TABLE II.—TREE AVERAGES—Continued.

AVERAGE RESULTS OF TESTS ON LONGLEAF YELLOW (OR "GEORGIA") PINE (PINUS PALUSTRIS) (REDUCED TO 15 PER CENT MOISTURE).

[The tabulated values are averages of tests from *individual trees.*]

Local conditions of growth.	Tree. No.	Tree. Age.	Dates of cutting and sawing.	Dates of green and dry tests.	Log diagrams.	Number of sticks tested.	Approximate dimensions (in inches).	Average specific gravity (not reduced for moisture).	Cross-bending tests. Modulus of rupture per square inch. $f=\frac{3Wl}{2bh^2}$	Cross-bending tests. Modulus of strength at elastic limit per square inch. $f'=\frac{3W'l}{2bh^2}$	Cross-bending tests. Modulus of elasticity. $E=\frac{W'l^3}{4\Delta bh^3}$	Cross-bending tests. Relative elastic resilience in inch-pounds per cubic inch.	Crushing strength endwise per square inch.	Crushing strength across the grain, per square inch. For 3 per cent distortion.	Crushing strength across the grain, per square inch. For 15 per cent distortion.	Tensile strength per square inch (not reduced for moisture).	Shearing strength per square inch.
									Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Station B., Ala. Upland forest, sloping to SW. Unboxed timber. Dense undergrowth of hardwoods.	16	202	April, 1891.	July & Aug., 1891	B 12' 6'; 20" 19"	23	4×4×60	0.753	11,564	8,587	1,816,773	2.64	7,583	1,110	1,456	17,388	754
			June, 1891.	July, 1892	12' 12' T; 16" 15"	3	5×9×140	0.785	10,516	8,753	Large sticks. 2,031,320	2.43	6,233	1,089	....	18,910	787
	17	162	April, 1891.	Aug., 1891	B 12' 6' 12' T; 20" 17" 16"	10	4×4×60	0.736	10,659	8,368	Small sticks. 1,791,075	2.55	6,763	1,016	1,193	11,164	821
			June, 1891.	July, 1892		2	5×10×136	0.757	9,959	9,615	Large sticks. 2,120,020	3.34	6,480	873	....	12,790	767
	18	210	April, 1891.	Aug. & Sept., 1891	B 12' 12' T; 22" 21"	7	4×4×60	0.700	10,912	7,733	Small sticks. 1,698,577	2.37	7,186	833	1,031	12,399	708
			June, 1891.	July, 1892		4	6×10×140	0.671	9,907	8,982	Large sticks. 2,082,480	2.83	6,437	839	....	9,310	678
	19	160	April, 1891.	Aug. & Sept., 1891	B 12' 12'; 26" 24"	12	4×4×60	0.696	12,338	9,043	Small sticks. 1,885,367	2.76	7,028	788	1,039	17,183	950
			June, 1891.	July, 1892	13'8" T; 22"	6	6×12×134	0.770	12,268	9,964	Large sticks. 2,212,666	3.06	6,023	827	....	14,755	871
	20	110	April, 1891.	Aug. & Sept., 1891	B 12' 18'8" T; 17" 16"	8	4×4×60	0.783	13,541	10,245	Small sticks. 2,181,456	3.29	7,648	1,196	1,754	20,182	972
			June, 1891.	July, 1892		2	4×8×140	0.775	14,826	10,805	Large sticks. 2,897,400	2.93	7,462	1,261	....	14,335	1,05
with trees of same years.	52	....	Oct., 1891.	Nov., 1891	B 20' 12' T; 29" 24"												
			Nov., 1891.	July & Aug., 1892		78	4×4×60	0.616	10,361	8,010	Small sticks. 1,553,978	2.39	6,432	992	1,219	12,518	760
	53	192	Oct., 1891.	Nov., 1891	B 20' 12' T; 30" 22"												
			Nov., 1891.	July & Aug., 1892		41	4×4×60	0.674	10,184	8,383	1,279,238	2.89	6,680	1,141	1,373	11,065	653

Wilson, Ala. Broad ridge, good pinelands, welltimbered, size. Box timber from orchard abandoned 5.	54	180	Oct., 1891 Nov., 1891	Nov., 1891 July, 1892	B 21" 12' T	8	4×4×60	0.804	12,756	9,332	1,913,175	3.15	7,332	1,388	1,866	19,340	905
	55	....	Oct., 1891 Nov., 1891	Nov., 1891 July, 1892	B 21" 12' T	10	4×4×60	0.720	12,221	9,694	1,781,640	3.07	7,440	1,210	1,556	15,968	759
	56	....	Oct. 1891 Nov. 1891	Nov. and Dec., 1891. July and Aug., 1892.	B 16" 12' T	8	4×4×60	0.787	13,893	9.874	2,080,875	3.14	8,172	1,214	1,598	18,327	952
	57	....	Oct. 1891 Nov. 1891	Nov., 1891 Aug., 1892	B 14" 12' T	8	4×4×60	0.747	13,082	9,727	1,829,862	3.25	7,551	1,323	1,742	14,996	932
	58	....	Oct. 1891 Nov. 1891	Nov., 1891 Aug., 1892	B 12" 12' T	8	4×4×60	0.767	12,634	9,549	1,959,075	2.99	7,884	1,274	1,639	19,306	922
	59	....	Oct. 1891 Nov. 1891	Nov., 1891 Aug., 1892	B 12" 12' T	6	4×4×60	0.877	13,253	9,798	1,992,035	3.04	8,361	1,559	1,928	18,237	1,148
Sheltered depression; rich soil.	60	225	Oct. 1891 Nov. 1891	Nov., 1891, and Jan., 1892. Aug., 1892	B 23" 20' 20" 12' T	23	4×4×60	0.726	12,410	9,662	1,865,196	3.18	7,491	1,299	1,572	16,017	839
	61	214	Oct. 1891 Nov. 1891	Nov. and Dec., 1891, and Jan., 1892. Aug., Sept., and Oct., 1892.	B 26" 20' 22" 12' T	48	4×4×60	0.711	11,807	8,908	1,725,494	2.81	7,171	1,164	1,432	15,319	907
Wilson, Ala.—Gravelly ridge, sloping to northeast. Recently boxed timber; worked for the last time in 1890.	62	....	Oct. 1891 Nov. 1891	Dec., 1891 Aug., 1892	B 21" 12' T	6	4×4×60	0.816	13,661	10,988	2,116,550	3.49	7,676	1,478	1,804	19,078	797
	63	200	Oct. 1891 Nov. 1891	Nov. and Dec., 1891. Aug., 1892.	B 12" 12' T	8	4×4×60	0.737	11,255	8,536	1,633,450	2.97	7,220	1,262	1,711	11,681	839
	64	....	Oct. 1891 Nov. 1891	Nov. and Dec., 1891. Aug., 1892	B 16" 12' T	8	4×4×69	0.835	13,221	10,780	2,100,925	3.44	8,069	1,267	1,740	18,089	917
	65	....	Oct. 1891 Nov. 1891	Nov. and Dec., 1892. Aug., 1892	B 15" 12' T	8	4×4×60	0.843	12,799	9,736	1,798,750	3.16	8,041	1,339	1,769	18,442	1,088
	66	91	Oct. 1891 Nov. 1891	Nov. and Dec., 1891. Aug., 1892	B 11" 12' T	4	4×4×60	0.797	12,981	9,077	1,789,000	3.02	7,733	1,332	1,816	15,165	1,106
	67	116	Oct. 1891 Nov. 1891	Nov. and Dec., 1891. Aug., 1892	B 12" 12' T	8	4×4×60	0.781	13,320	10,585	2,105,212	3.46	8,325	1,140	1,583	17,577	1,062
General averages, giving all trees equal weight								.742	12,25	9,430	2,069,650	2.94	7,228	1,133	1,517	16,029	852

TABLE III.—Comparative Strength of Different Trees.

Specimens taken from first 20 feet of tree trunk. Results of tests on Long-leaf Yellow (or Georgia) Pine (Pinus palustris). Reduced to 15 per cent moisture. [The numbers given in light-faced type are the percentages; the several results are the average of all of that class.]

[The tabulated values are averages of tests from butt cuts (from 12 to 20 feet long) of individual trees.]

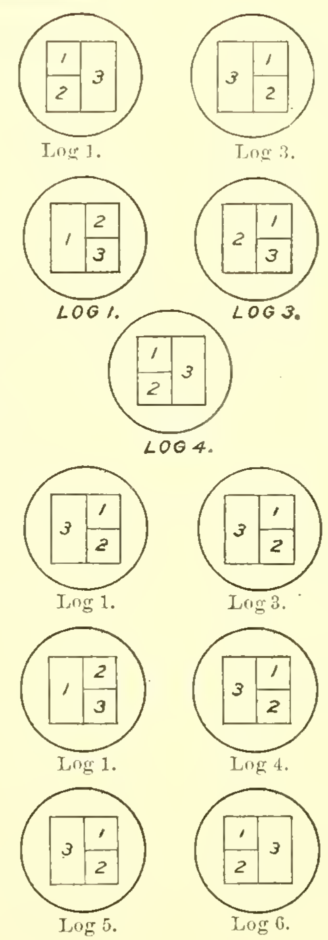
	1		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
									Cross-bending tests.					Crushing strength across the grain per square inch.								
Local conditions of growth.	Number of tree.	Age.	Dates of cutting and sawing.	Dates of green and dry tests.	Number of sticks tested.	Approximate dimensions (in inches).	Standard percentage of moisture.	Average specific gravity (not reduced for moisture).	Modulus of rupture per square inch. $f=\frac{3Wl}{2bh^2}$	Modulus of strength at elastic limit per square inch. $f=\frac{3Wl}{bh^2}$	Modulus of elasticity. $E=\frac{3Wl^3}{4\Delta bh^3}$	Relative elastic resilience in inch-pounds per cubic inch.	Crushing strength endwise per square inch.	For 3 per cent distortion.	For 15 per cent distortion.	Tensile strength per square inch (not reduced for moisture).	Shearing strength per square inch.	Per cent each tree is of its group.	Per cent each tree is of its kind.	Per cent each group is of its kind.	Per cent each kind is of the whole, giving each kind equal weight.	Per cent each tree is of the whole.
									Pounds.	*Pounds.*			*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*					
Unboxed.	1	182	Nov. 1890	July 1891					101.4	98.6	103.1	94.9	103.9	96.1		107.4	103.7	101.1		100	96.6	
			Feb. 1891	Aug. 1892.......	7	4x4x60	15	0.753	12,664	9,057	2,084,243	2.6	7,370	1,004	1,410	20,347	744	....	104.1			971
	2	196	Nov. 1890	July 1891					98.0	97.6	95.2	100.7	99.1	95.9		82.2	87.8	94.6				
			Feb. 1891	July, Aug., 1892	6	4x4x60	15	0.763	12,244	8,962	4,922,260	2.77	7,031	1,002	1,327	15,564	630	....	94.6			90.9
	3	183	Nov. 1890	July 1891					98.9	100.0	108.0	92.4	97.0	94.0		107.6	92.6	98.8				
			Feb. 1891	Aug. 1892.......	4	4x4x60	15	0.729	12,345	9,187	2,180,977	2.54	6,881	982	1,394	20,369	664	....	98.8			94.9
	4	189	Nov. 1890	July, Aug., 1891					99.3	103.9	84.9	117.5	103.0	104.8		102.1	100.9	102.1				
			Feb. 1891	July, Aug., 1892	7	4x4x60	15	0.739	12,398	9,548	1,714,700	3.23	7,311	1.095	1,741	19,332	724	....	102.1			98.1
	5	226	Nov. 1890	July 1891					102.4	99.9	108.8	94.5	97.1	109.2		100.7	115.0	103.4				
			Feb. 1891	....	24	4x4x60	15	0.762	12,796	9,174	2,197,808	2.60	6,891	1,141		19,081	825		103.4			99.3
Unboxed.	16	202	April 1891	July, Aug., 1891					95.0	95.2	92.7	96.9	102.5	114.8		102.4	85.5	98.1		100		
			June 1891	July 1892	15	4x4x60	15	0.773	11,616	8,506	1,826,229	2.55	7,417	1,145	1,488	18,461	742		98.1			94.2
	17	163	April 1891	Aug., Sept., 1891					92.3	95.5	97.2	90.8	97.5	102.5		81.7	97.4	94.4				
			June 1891	July 1892	6	4x4x60	15	0.753	11,289	8,534	1,915,380	2.39	7,064	1.023	1,444	14,732	846		94.4			90.7
	18	210	April 1891	Aug., Sept., 1891					90.8	88.0	91.9	90.8	95.8	85.7		77.5	95.2	89.5				
			June 1891	July 1892	3	4x4x60	15	0.734	11.098	7,863	1,811,600	2.39	6,929	855	1,216	13,977	827		89.5			86.0
	19	160	April 1891	Aug. 1891					104.8	103.0	99.6	100.7	97.5	79.9		112.0	114.5	101.5				
			June 1891	July 1892	4	4x4x60	15	0.698	12,808	9,202	1,962,975	2.65	7,052	797	1,047	20,210	994		101.5			97.5
	20	110	April 1891	Aug., Sept., 1891					117.2	118.2	118.6	120.9	106.7	117.1		126.4	107.4	116.5				
			June 1891	July 1892	4	4x4x60	15	0.782	14,326	10,555	2,338,745	3.18	7,713	1,168	1,931	22,792	933		116.5			111.9
Boxed 5 years before cutting.	52	......	Oct. 1891	Nov., Dec., 1891					89.3	91.8	91.9	87.7	90.0	83.4		81.8	81.1	87.1		97.9		
			Nov. 1891	Jan., July, 1892	40	4x4x60	15	0.661	11,240	8,682	1,696,570	2.67	6,817	1,063	1,303	13,593	710		85.3			87.5
	53	192	Oct. 1891	Nov., Dec., 1891					92.2	95.4	81.9	99.9	93.0	91.3		79.5	76.8					
			Nov. 1891	Jan., July, 1892	19	4x4x60	15	0.732	11,606	9,020	1,512,458	3.04	7,045	1,464	1,405	13,220	672	88.8	86.9			88.4
	54	180	Oct. 1891	Nov. 1891					101.3	98.7	103.7	103.5	96.8	108.9		116.3	103.4					
			Nov. 1891	July 1892	8	4x4x60	15	0.804	12,756	9,332	1,913,175	3.15	7,332	1,388	1,866	19,340	905	101.1	101.9			104.4
	55	......	Oct. 1891	Nov. 1891					97.1	102.5	96.5	100.8	98.2	94.9		96.1	86.7	96.6				
			Nov. 1891	July 1892	10	4x4x60	15	0.720	12,221	9,691	1,781,640	3.07	7,440	1,210	1,556	15,968	759		94.6			97.0
	56	......	Oct. 1891	Nov., Dec., 1891					110.4	104.4	112.7	103.2	107.6	95.3		110.2	108.8	106.6				
			Nov. 1891	July, Aug., 1892	8	4x4x60	15	0.787	13,893	9,874	2,080,875	3.14	8,172	1,214	1,598	18,327	952		104.4			107.4
	57	......	Oct. 1891	Nov. 1891					103.9	102.8	99.1	106.8	99.6	103.8		90.2	106.5	101.6				
			Nov. 1891	Aug. 1892.......	8	4x4x60	15	0.747	13,082	9,727	1,829,862	3.25	7,551	1,323	1,742	14,996	932		99.5			102.0
	58	......	Oct. 1891	Nov. 1891					100.4	101.0	106.1	98.2	104.1	100.0		116.1	105.4	103.9				
			Nov. 1891	Aug. 1892.......	8	4x4x60	15	0.767	12,634	9,549	1,959,075	2.99	7,884	1,274	1,639	19,306	922		101.7			104.3
	59	......	Oct. 1891	Nov. 1891					105.3	103.6	107.9	99.9	110.4	122.3		109.7	131.2					
			Nov. 1891	Aug. 1892......	6	4x4x60	15	0.777	13,253	9,798	1,992,035	3.04	8,361	1,559	1,928	18,237	1,148	111.3	109.0			111.8

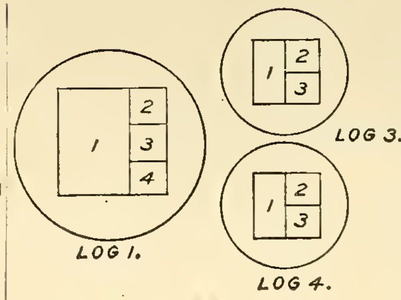
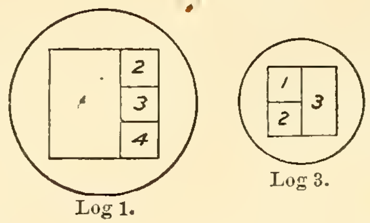
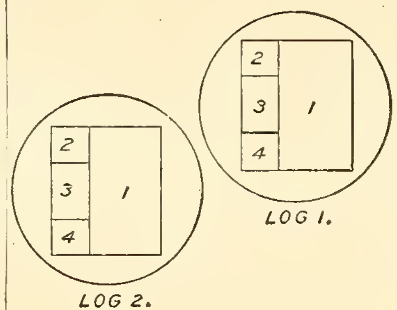
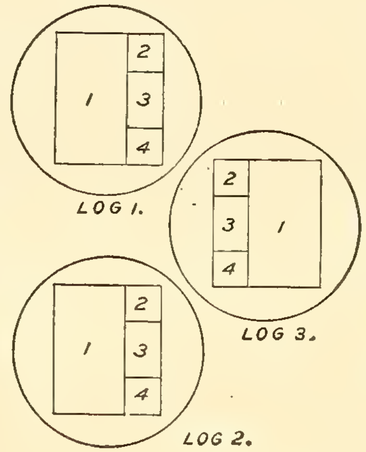
Recently boxed.	60	225	Oct. 1891	Nov., Dec., 1891					100.9	101.9	99.6	106.1	99.8	103.5		96.7	88.0				103.4	
			Nov. 1891	Jan., Aug., 1892	15	4x4x60	15	0.767	13,078	10,148	1,911,106	3.48	7,794	1,347	1,582	16,137	834	99.6	101.7			104.3
	61	214	Oct. 1891	Nov., Dec., 1891					103.2	98.8	98.7	97.9	97.9	98.3		103.7	99.3					
			Nov. 1891	Jau., Aug., 1892	21	4x4x60	15	0.788	13,376	9,846	1,894,267	3.21	7,647	1,280	1,899	17,300	941	99.7	101.8			104.4
	62	......	Oct. 1891	Dec. 1891					105.4	110.3	110.3	106.4	98.2	113.5		114.3	84.1					
			Nov. 1891	Aug. 1892	6	4x4x60	15	0.816	13,661	10,988	2,116,550	3.49	7,676	1,478	1,804	19,078	797	105.3	107.5			110.3
	63	200	Oct. 1891	Nov., Dec., 1891					86.8	85.7	85.1	90.6	92.4	96.9		70.0	88.5					
			Nov. 1891	Aug. 1892	8	4x4x60	15	0.737	11,255	8,536	1,633,450	2.97	7,220	1,262	1,711	11,681	839	87.0	88.8	102.1		91.1
	64	......	Oct. 1891	Nov., Dec., 1891					102.0	108.2	109.5	104.9	103.3	97.3		108.4	96.7					
			Nov. 1891	Aug. 1892	8	4x4x60	15	0.835	13,221	10,780	2,100,925	3.44	8,069	1,267	1,740	18,089	917	103.8	106.0			108.7
	65	......	Oct. 1891	Nov., Dec., 1891					98.8	97.7	93.8	96.3	102.9	100.5		110.5	114.8					
			Nov. 1891	Aug. 1892	8	4x4x60	15	0.843	12,799	9,736	1,798,750	3.16	8,041	1,309	1,769	18,442	1,088	101.9	104.0			106.7
	66	91	Oct. 1891	Nov., Dec., 1891					100.2	91.1	93.2	92.1	98.9	102.3		90.9	116.7					
			Nov. 1891	Aug. 1892	4	4x4x60	15	0.797	12,981	9,077	1,789,000	3.02	7,733	1,332	1,816	15,165	1,106	98.2	100.2			102.8
	67	116	Oct. 1891	Nov., Dec., 1891					102.8	106.3	109.7	105.5	106.5	87.6		105.9	112.0					
			Nov. 1891	Aug. 1892	8	4x4x60	15	0.781	13,320	10,585	2,105,212	3.46	8,305	1,140	1,583	17,577	1,062	104.5	106.7			109.4
									101.0	101.4	101.2	102.2	99.0	102.3		102.9	90.4					
Averages of first group, 5 unboxed trees					....	....	....	0.749	12,489	9,186	2,019,398	2.75	7,097	1,045	1,468	18,939	717	100				
									99.0	98.6	98.8	97.8	101.0	97.7		97.6	109.6					
Averages of second group, 5 unboxed trees					....	....	....	0.748	12,227	8,932	1,970,986	2.63	7,235	998	1,425	18,035	868	100				
									98.5	97.4	98.1	96.2	98.5	98.9		99.8	96.1					
Averages of third group, 8 trees, boxed 5 years before cutting					....	....	....	0.762	12,586	9,459	1,845,711	3.04	7,575	1,274	1,630	16,623	875	97.9				
									101.5	102.6	101.9	103.8	101.5	101.1		100.2	103.9					
Averages of fourth group, 8 trees, recently boxed.					....	....	....	0.795	12,961	9,962	1,918,657	3.28	7,813	1,302	1,738	16,684	948	102.1				
									98.3	96.5	102.9	92.2	96.4	88.5		105.2	93.1	96.6				
Averages of first and second groups, 10 unboxed trees					....	....	....	0.749	12,358	9,059	1,995,192	2.69	7,166	1,021	144	18,487	793					
									101.7	103.5	97.1	107.8	103.6	111.5		94.8	106.9	103.4				
Averages of third and fourth group, 16 boxed trees					....	....	....	0.779	12,774	9,710	1,882,184	3.16	7,694	1,288	1,684	16,654	912					
Mean values of boxed and unboxed trees					....	....	....	0.764	12,566	9,385	1,938,688	2.93	7,430	1,155	1,565	17,570	853					
Averages of all trees (26)					265	4x4x60	15	0.767	12,614	9,460	1,925,644	2.98	7,452	1,185	1,598	17,359	866					

TABLE IV.—Relative Unit Strength and Stiffness of Large and Small Beams from Same Logs.

Local conditions of growth.	Trees. No.	Trees. Age.	Dates of cutting and sawing.	Dates of tests.	No. of log and of stick.	Approximate dimensions in inches.	Percentage of moisture.	Specific gravity (not reduced for moisture).	Cross-bending tests. Actual results of tests. Modulus of rupture per square inch. $f=\frac{3Wl}{2bh^2}$	Actual results of tests. Modulus of strength at elastic limit per square inch. $f'=\frac{3W'l}{2bh^2}$	Actual results of tests. Modulus of elasticity. $E=\frac{Wl^3}{4\Delta bh^3}$	Results reduced to 15 per cent moisture. Modulus of rupture per square inch. $f=\frac{3Wl}{2bh^2}$	Results reduced to 15 per cent moisture. Modulus of strength at elastic limit per square inch. $f'=\frac{3W'l}{2bh^2}$	Results reduced to 15 per cent moisture. Modulus of elasticity. $E=\frac{Wl^3}{4\Delta bh^3}$	Average results of tests on 4×4 inch sticks in the same log, reduced to 15 per cent moisture. Modulus of rupture per square inch. $f=\frac{3Wl}{2bh^2}$	Average results … Modulus of strength at elastic limit per square inch. $f'=\frac{3W'l}{2bh^2}$	Average results … Modulus of elasticity. $E=\frac{Wl^3}{4\Delta bh^3}$
Wallace, Ala., upland forest rather dense for the species. Unboxed timber.	1	182	Nov., 1890	July, 1891	1, 3	4× 8×144	19.4	0.803	*Pounds.* 13,220	*Pounds.* 10,940	2,610,000	*Pounds.* 15,002	*Pounds.* 12,140	2,714,800	*Pounds.* 12,793	*Pounds.* 9,305	1,926,425
			Feb., 1891	Aug., 1891	3, 3	4× 8×140	25.3	0.602	14,200	9,650	2,400,000	17,128	11,790	2,588,600	12,950	9,295	1,762,750
	2	196	Nov., 1890	Aug., 1891	1, 1	4× 8×140	20.0	0.778	12,100	10,690	2,400,000	14,050	12,020	2,486,000	12,366	9,280	1,934,500
					3, 2	4× 8×140	19.2	0.720	10,600	9,020	2,222,000	12,326	10,180	2,292,240	11,949	9,207	1,770,640
			Feb., 1891	Aug., 1891	4, 3	4× 8×164	18.1	0.662	8,570	8,510	1,840,000	9,952	9,480	1,893,320	10,579	7,830	1,459,620
	3	183	Nov., 1890	July, 1891	1, 3	4× 8×144	20.3	0.687	12,610	10,600	2,890,000	14,629	11,990	3,117,370	12,172	9,055	1,999,275
			Feb., 1891	July, 1891	*3, 3	4× 8×144	21.8	0.665	12,280	7,390	2,690,000	14,628	9,050	2,981,720	11,038	8,743	1,706,805
	4	189	Nov., 1890	July, 1891	1, 1	4× 8×144	22.0	0.688	12,830	10,800	2,600,000	15,220	12,490	2,745,000	12,777	9,587	1,751,800
					4, 3	4× 8×144	20.7	0.652	10,910	9,820	1,930,000	13,021	11,280	2,056,200	9,159	7,560	1,479,225
			Feb., 1891	Aug., 1891	5, 3	4× 8×106	18.7	0.652	9,280	5,580	2,250,000	10,854	6,630	2,342,600	8,533	6,280	1,523,700
					6, 3	4× 8×106	18.3	0.607	6,510	4,530	1,710,000	7,956	5,490	1,795,400	9,207	7,095	1,307,150

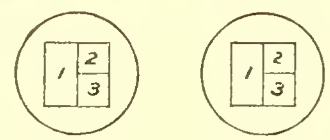
Log diagram.



Upland forest. Unboxed timber. Dense undergrowth of hard woods.	16	202	Apr., 1891	Aug., 1891	 LOG 1. LOG 3. LOG 4.	1, 1	6×12×136	24.6	0.828	7,090	6,650	2,050,000	9,915	8,710	2,105,680	12,326	8,203	1,821,280
						3, 1	4× 8×140	16.4	0.768	10,910	8,080	2,070,000	11,598	8,540	2.078,120	11,196	8,427	1,750,555
			June, 1891	Aug., 1891		4, 1	4× 8×140	20.2	0.760	8,040	7,640	1,880,000	10,036	9,010	1,910,160	11,746	8,032	1,849,895
	17	162	Apr., 1891	Aug., 1891	 Log 1. Log 3.	*1, 1	6×12×132	22.8	0.804	5,780	6,820	1,620,000	8,338	8,630	1,665,240	11,289	8,534	1,915,380
			June, 1891	Sept., 1891		3, 3	4× 8×140	21.0	0.710	9,420	9,080	2,540,000	11,600	10,600	2,574,800	9,871	8,160	1,635,695
	18	210	Apr., 1891	Oct., 1891	 LOG 1. LOG 2.	1, 1	7×14×140	21.5	0.673	6,910	6,620	1,760,000	9,195	8,230	1,871,800	11,098	7,863	1,811,600
				Sept., 1891		*2, 1	7×14×140	20.9	0.664	7,640	7,640	1,790,000	9,797	9,140	1,891,480	10,773	7,635	1,613,810
			June, 1891	Aug., 1891		2, 3	4× 6×140	17.7	0.671	6,540	5,400	2,170,000	7,776	6,210	2,216,440	....	....	....
				Sept., 1891		1, 3	4× 6×116	18.5	0.675	11,350	11,350	2,290,000	12,860	12,350	2,350,200	....	....	....
	19	160	Apr., 189	Oct., 1891	 LOG 1. LOG 3. LOG 2.	*1, 1	8×16×136	30.0	0.809	6,330	....	1,700,000	9,855	....	1,945,000	12,808	9,202	1,962,975
				Aug., 1891		1, 3	4× 8×140	20.1	0.832	12,670	10,150	2,370,000	14,643	11,500	2,486,600	....	....	....
				Oct., 1891		2, 1	8×16×134	25.0	0.724	7,880	6,230	1,850,000	10,765	8,340	2,035,000	12,473	9,350	1,924,450
			June, 1891	Aug., 1891		2, 3	4× 8×138	20.2	0.780	12,040	10,030	2,240,000	14,036	11,400	2,358,200	....	....	....
				Sept., 1891		3–1, 3–3	7×14×140 4× 6×160	25.0 20.7	0.722 0.752	7,970 11,320	5,670 8,340	1,840,000 2,300,000	10,855 13,454	8,780 9,800	2,025,000 2,426,200	11,734	8,578	1,768,675

* Failed by shearing along neutral axis.

TABLE IV.—RELATIVE UNIT STRENGTH AND STIFFNESS OF LARGE AND SMALL BEAMS FROM SAME LOGS—Continued.

Local conditions of growth.	Trees.		Dates of cutting and sawing.	Dates of tests.	Log diagram.	No. of log and of stick.	Approximate dimensions in inches.	Percentage of moisture.	Specific gravity (not reduced for moisture).	Cross-bending tests.								
										Actual results of tests.			Results reduced to 15 per cent moisture.			Average results of tests on 4×4 inch sticks in the same log, reduced to 15 per cent moisture.		
	No.	Age.								Modulus of rupture per square inch. $f=\frac{3Wl}{2bh^2}$	Modulus of strength at elastic limit per square inch. $f^1=\frac{3W'l}{2bh^2}$	Modulus of elasticity. $E=\frac{Wl^3}{4\Delta bh^3}$	Modulus of rupture per square inch. $f=\frac{3Wl}{2bh^2}$	Modulus of strength at elastic limit per square inch. $f^1=\frac{3W'l}{2bh^2}$	Modulus of elasticity. $E=\frac{Wl^3}{4\Delta bh^3}$	Modulus of rupture per square inch. $f=\frac{3Wl}{2bh^2}$	Modulus of strength at elastic limit per square inch. $f^1=\frac{3W'l}{2bh^2}$	Modulus of elasticity. $E=\frac{Wl^3}{4\Delta bh^3}$
										Pounds.	*Pounds.*		*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	
	20	110	Apr., 1891	Aug., 1891	 Log 1. Log 2.	1[illegible] 1[illegible]	4× 1408×	19.6	0.801	12,260	8,410	2,900,000	14,098	9,660	3,097,340	14,326	10,555	2,338,770
			June, 1891	Sept., 1891		2[illegible] 1[illegible]	4× 8×140	21.4	0.748	13,290	10,360	2,380,000	15,554	11,950	2,697,460	12,755	9,915	2,024,168

	Large beams.			Small beams.		
Mean results on the larger sizes (excluding beams which failed by shearing), compared with mean results from 4×4-inch beams from same logs:						
3 sticks, 4×6 inches	11,363	9,453	2,330,947	11,202	8,025	1,731,362
17 sticks, 4×8 inches	13,130	10,289	2,456,441	11,594	8,715	1,779,911
1 stick, 6×12 inches	9,915	8,710	2,105,680	12,326	8,203	1,821,280
2 sticks, 7×14 inches	10,025	8,505	1,948,400	11,416	8,221	1,790,138
1 stick, 8×16 inches	10,765	8,340	2,035,000	12,473	9,350	1,924,450

* Failed by shearing along neutral axis.

PLATE I.

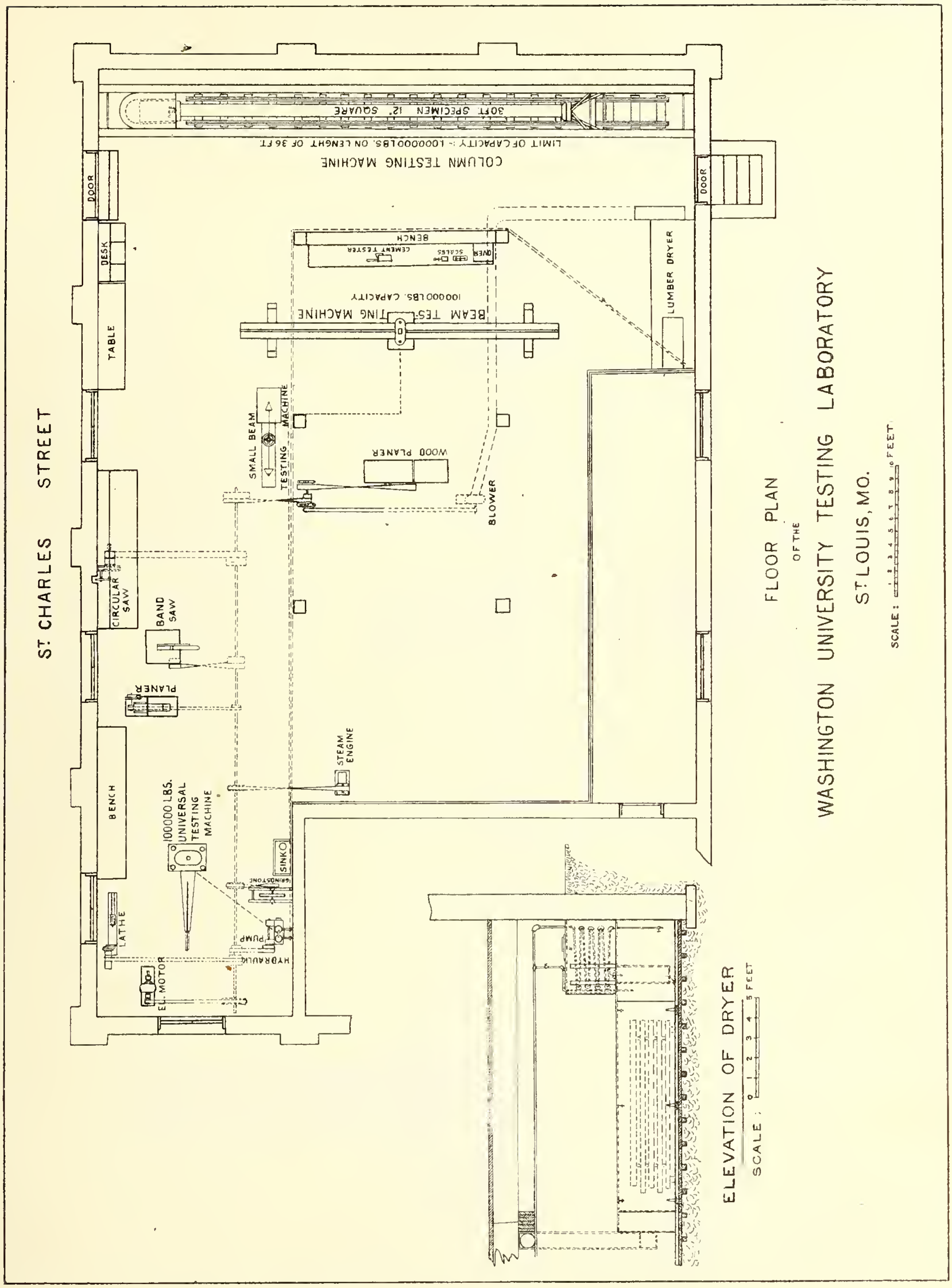
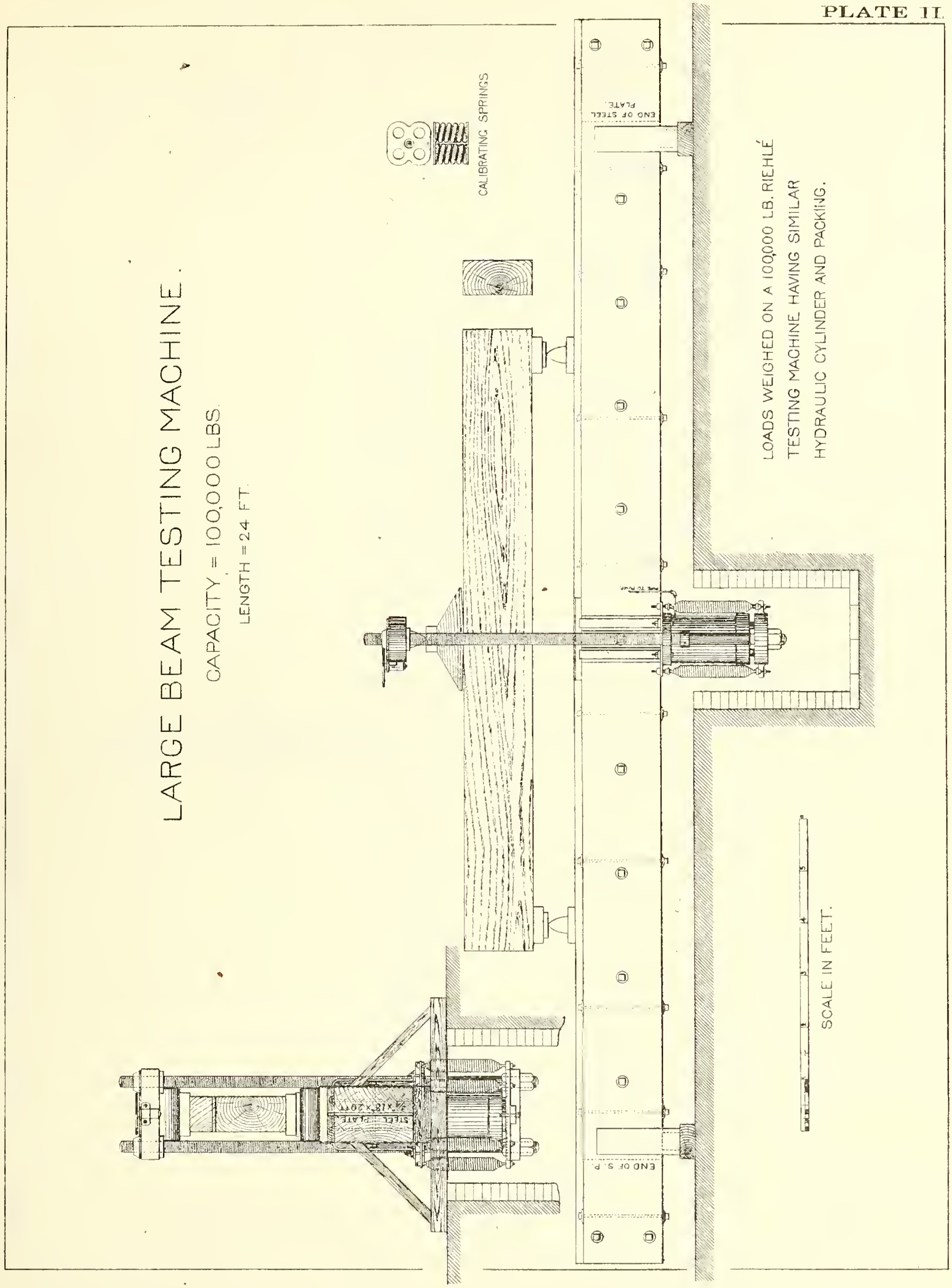
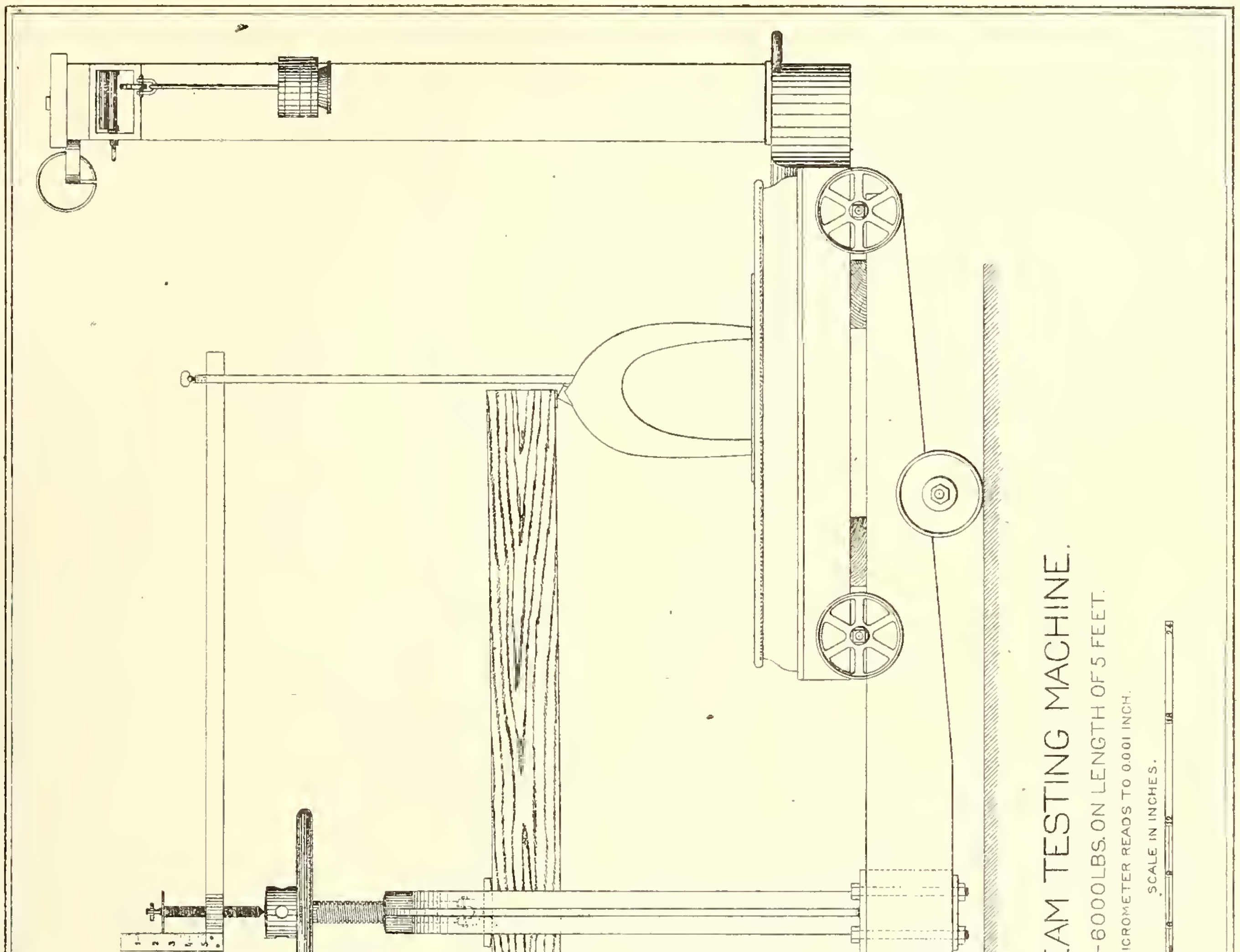

ST. CHARLES STREET
DOOR
DESK
TABLE
CIRCULAR SAW
BAND SAW
PLANER
BENCH
LATHE
EL. MOTOR
HYDRAULIC PUMP
100000 LBS. UNIVERSAL TESTING MACHINE
SINK
GRINDSTONE
STEAM ENGINE
SMALL BEAM TESTING MACHINE
BLOWER
WOOD PLANER
BEAM TESTING MACHINE
100000 LBS. CAPACITY
BENCH
CEMENT TESTER
SCALES
OVEN
LUMBER DRYER
DOOR
COLUMN TESTING MACHINE
LIMIT OF CAPACITY :- 1000000 LBS. ON LENGHT OF 36 FT.
30 FT. SPECIMEN 12" SQUARE
FLOOR PLAN OF THE WASHINGTON UNIVERSITY TESTING LABORATORY ST. LOUIS, MO.
SCALE: FEET
ELEVATION OF DRYER
SCALE: 0 1 2 3 4 5 FEET

PLATE II.


LARGE BEAM TESTING MACHINE.
CAPACITY = 100,000 LBS.
LENGTH = 24 FT.
CALIBRATING SPRINGS
END OF STEEL PLATE.
END OF S. P.
LOADS WEIGHED ON A 100,000 LB. RIEHLÉ
TESTING MACHINE HAVING SIMILAR
HYDRAULIC CYLINDER AND PACKING.
SCALE IN FEET.



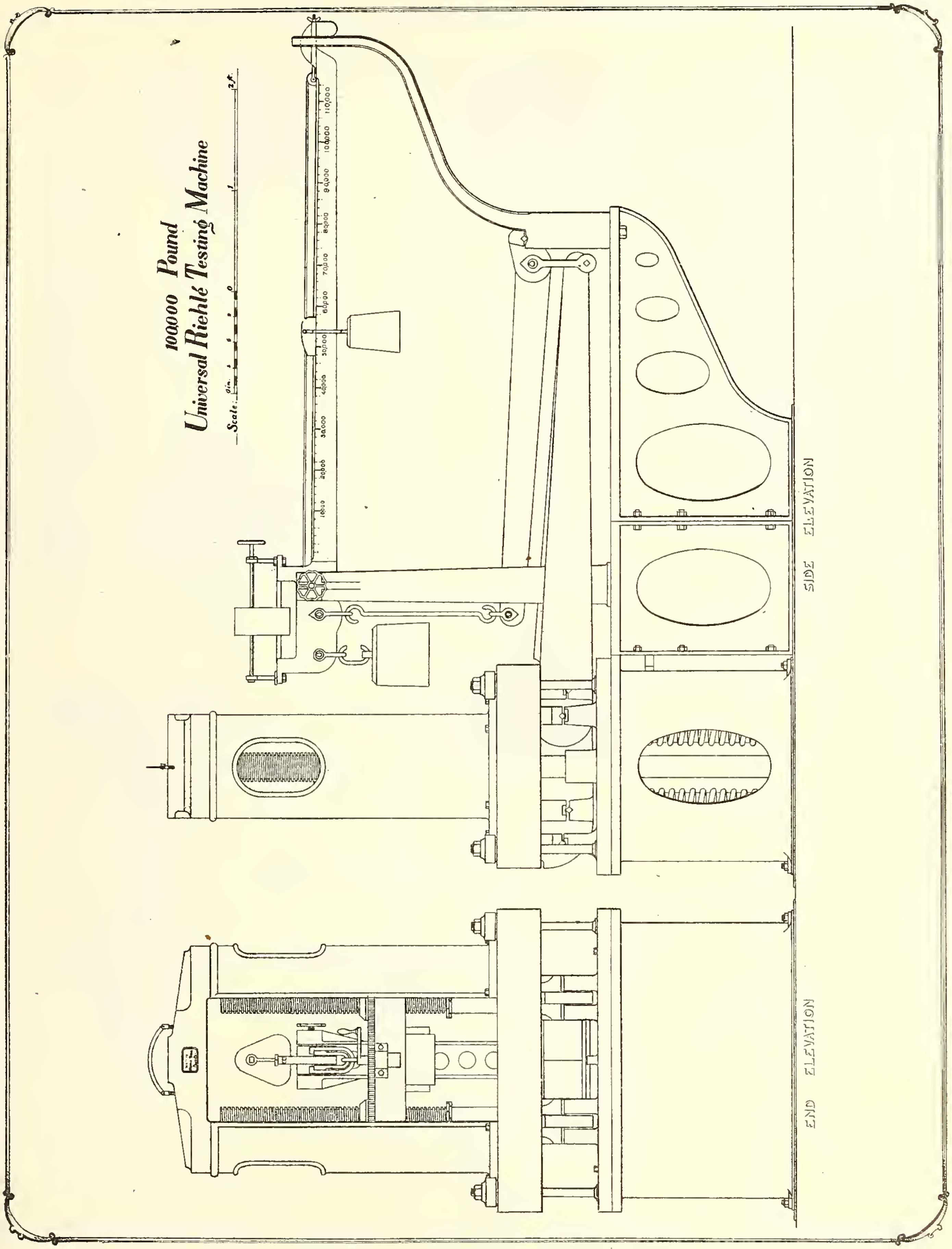
SMALL BEAM TESTING MACHINE.

CAPACITY—6000 LBS. ON LENGTH OF 5 FEET.

MICROMETER READS TO 0.001 INCH.

SCALE IN INCHES.

PLATE IV.



100000 Pound
Universal Riehlé Testing Machine
Scale
SIDE ELEVATION
END ELEVATION

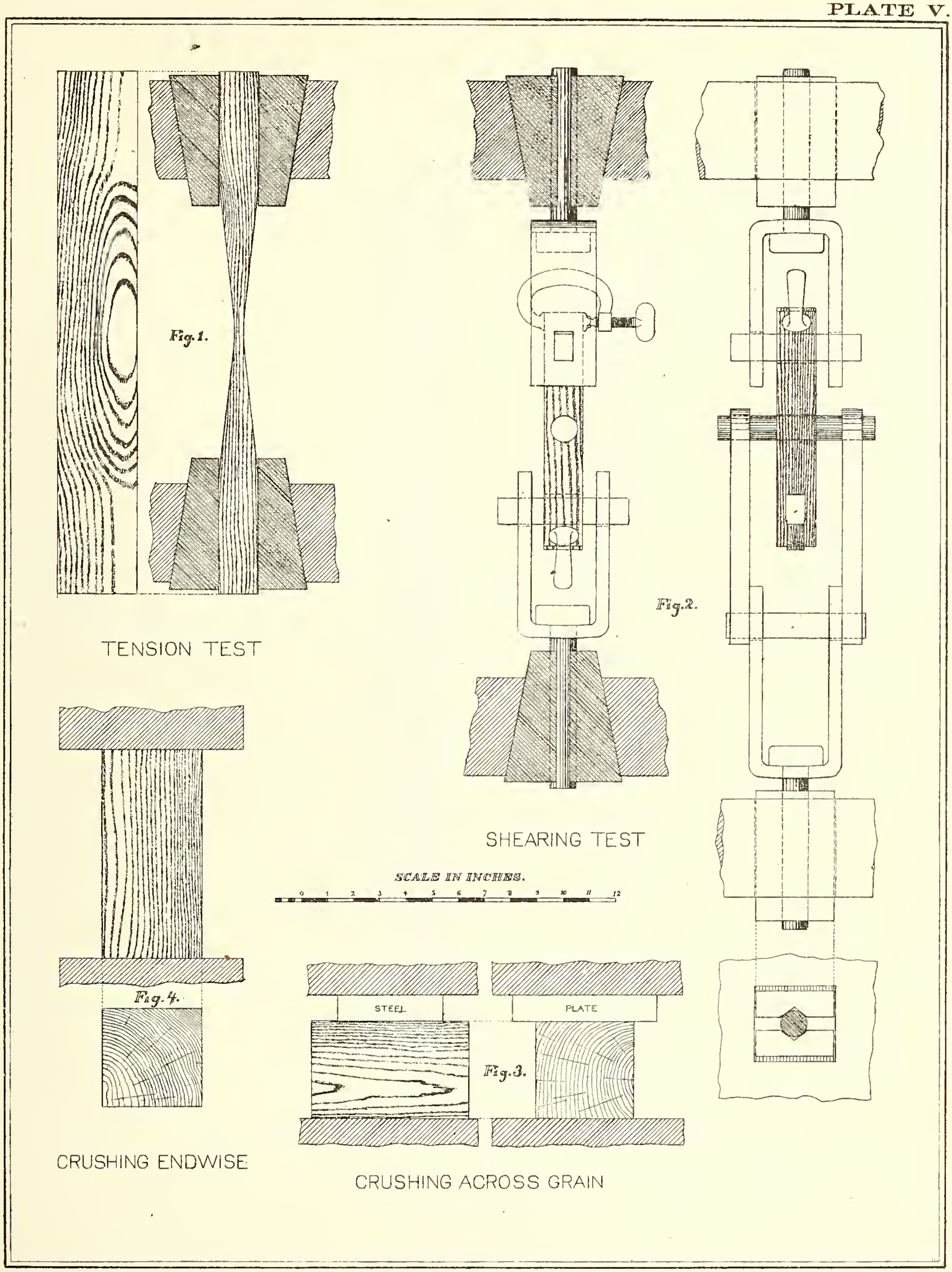
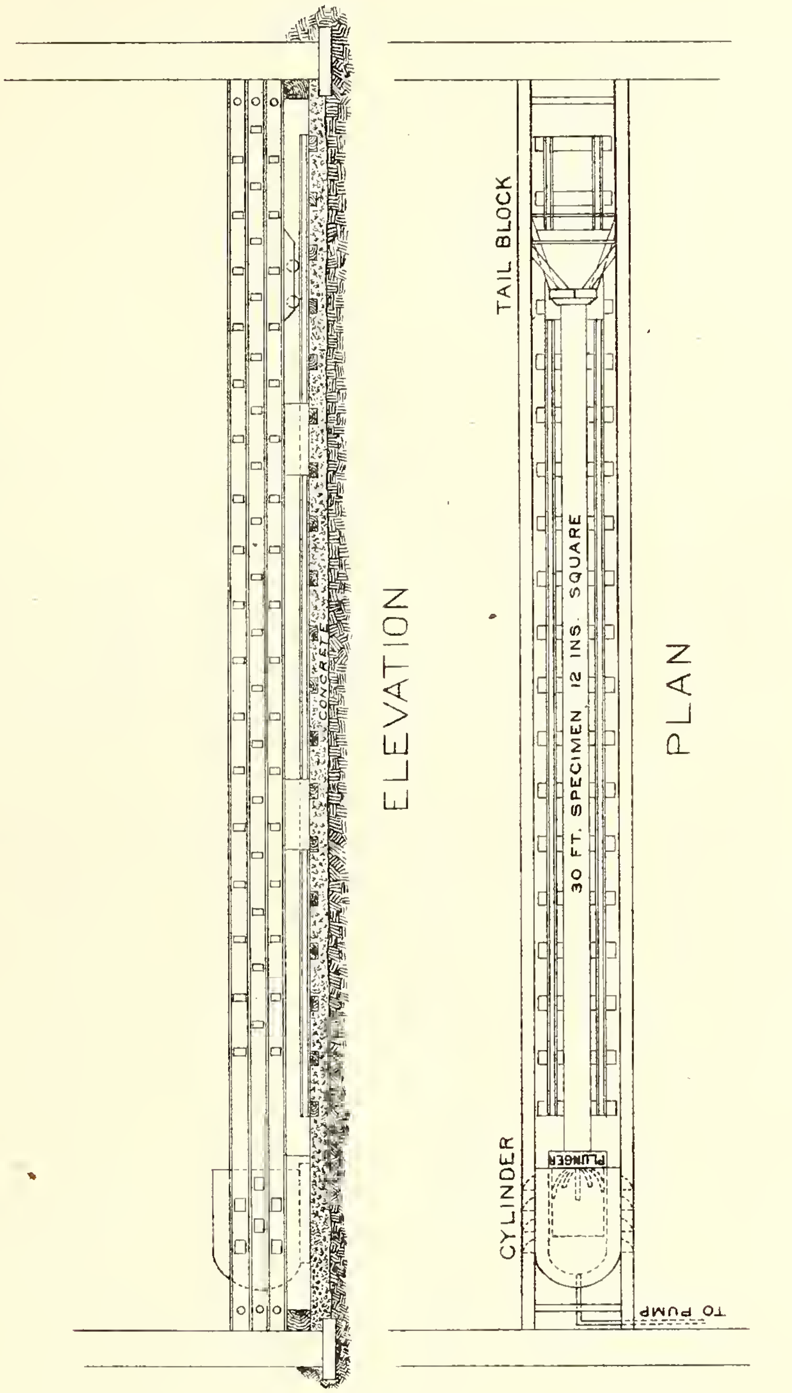


Fig. 1.
TENSION TEST
Fig. 2.
SHEARING TEST
SCALE IN INCHES.
0 1 2 3 4 5 6 7 8 9 10 11 12
Fig. 4.
CRUSHING ENDWISE
STEEL
PLATE
Fig. 3.
CRUSHING ACROSS GRAIN



COLUMN TESTING MACHINE

Limit of Capacity :– 1,000,000 Lbs. on Length of 36 Ft.

SCALE :– 1 2 3 4 5 6 7 8 9 10 FEET

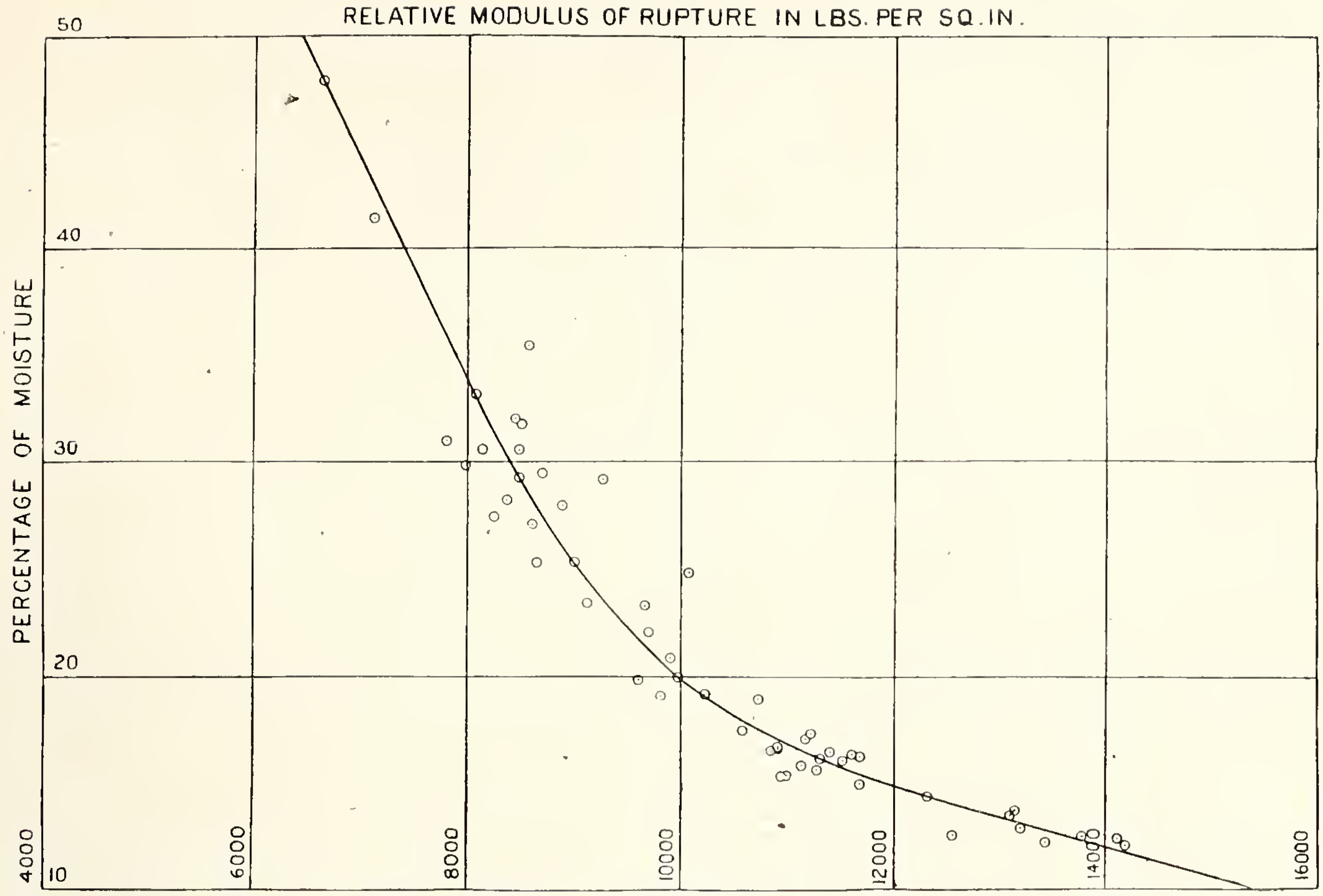


Fig. 1.—Diagram showing the increase in the modulus of rupture in cross-breaking, with decrease in percentage of moisture.

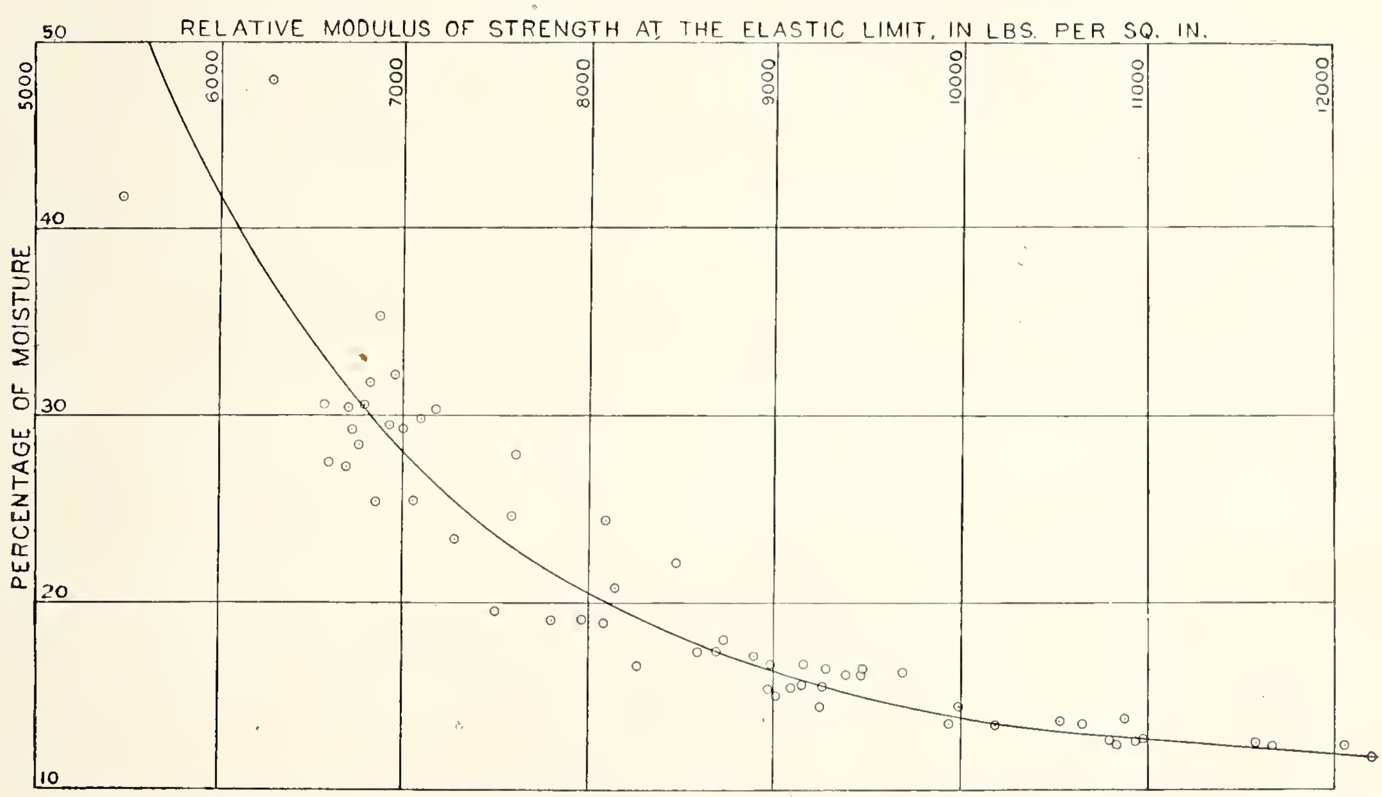


Fig. 2.—Diagram showing the increase in the modulus of strength at the elastic limit, with decrease in the percentage of moisture.

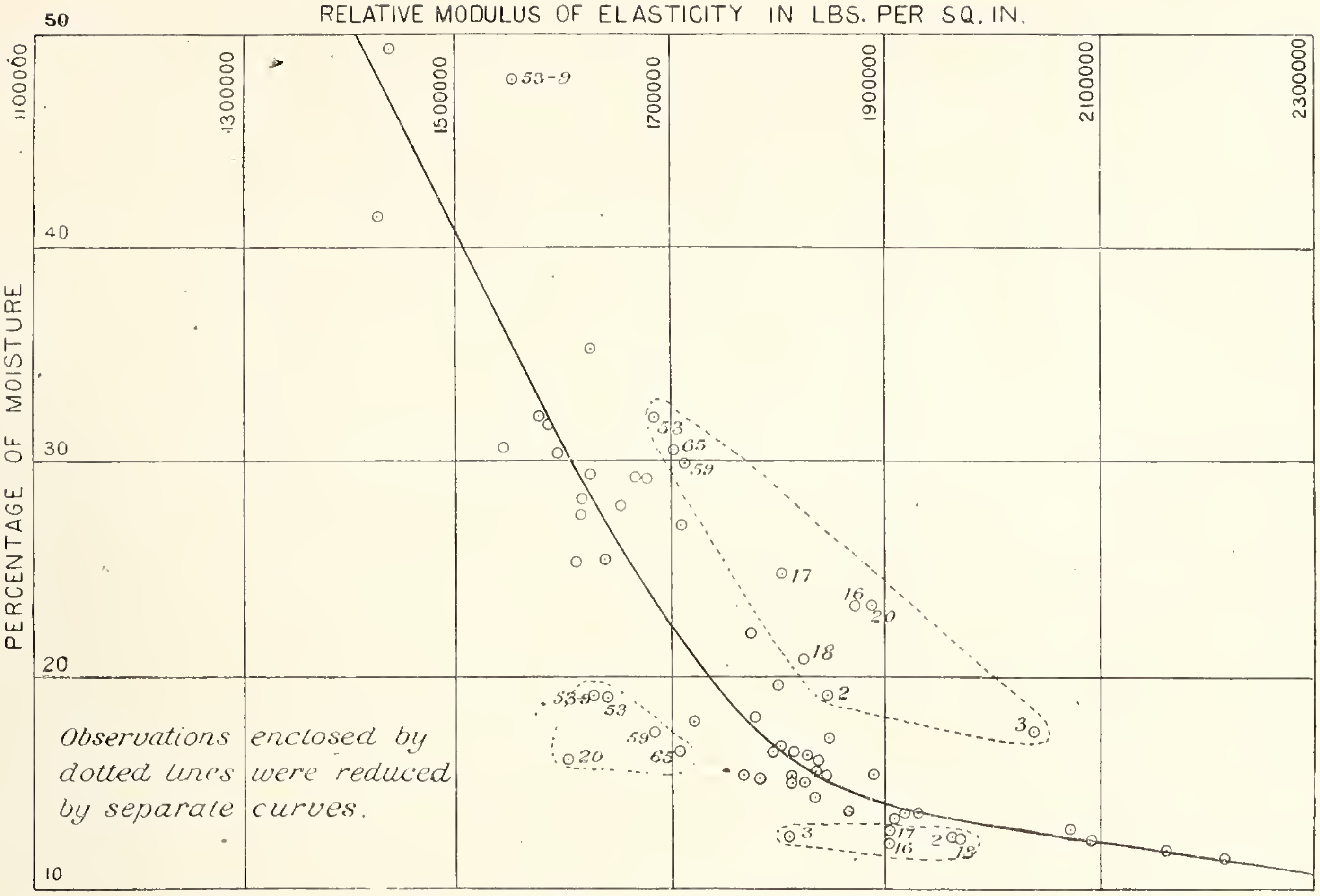


Fig. 1.—Diagram showing the increase in the modulus of elasticity or the modulus of stiffness, with decrease in the percentage of moisture.

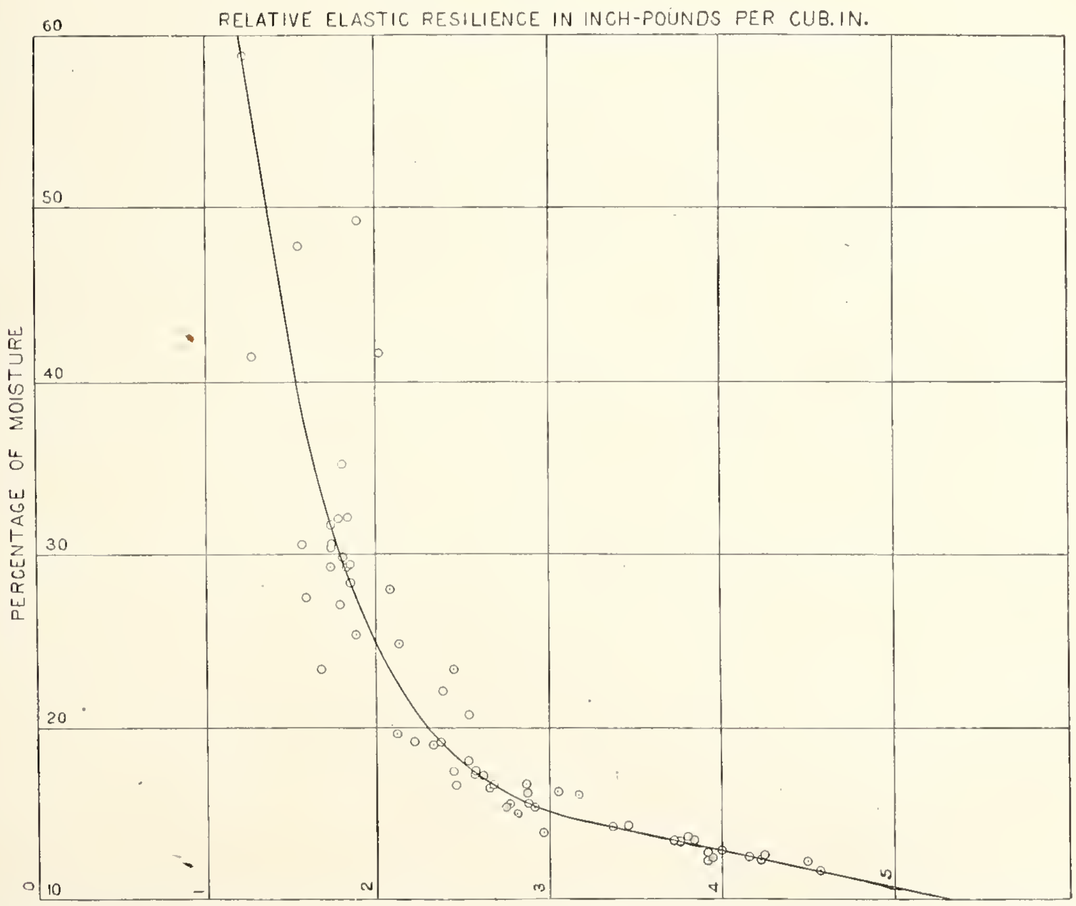


Fig. 2.—Diagram showing the decrease in the relative elastic resilience, with decrease in the percentage of moisture.

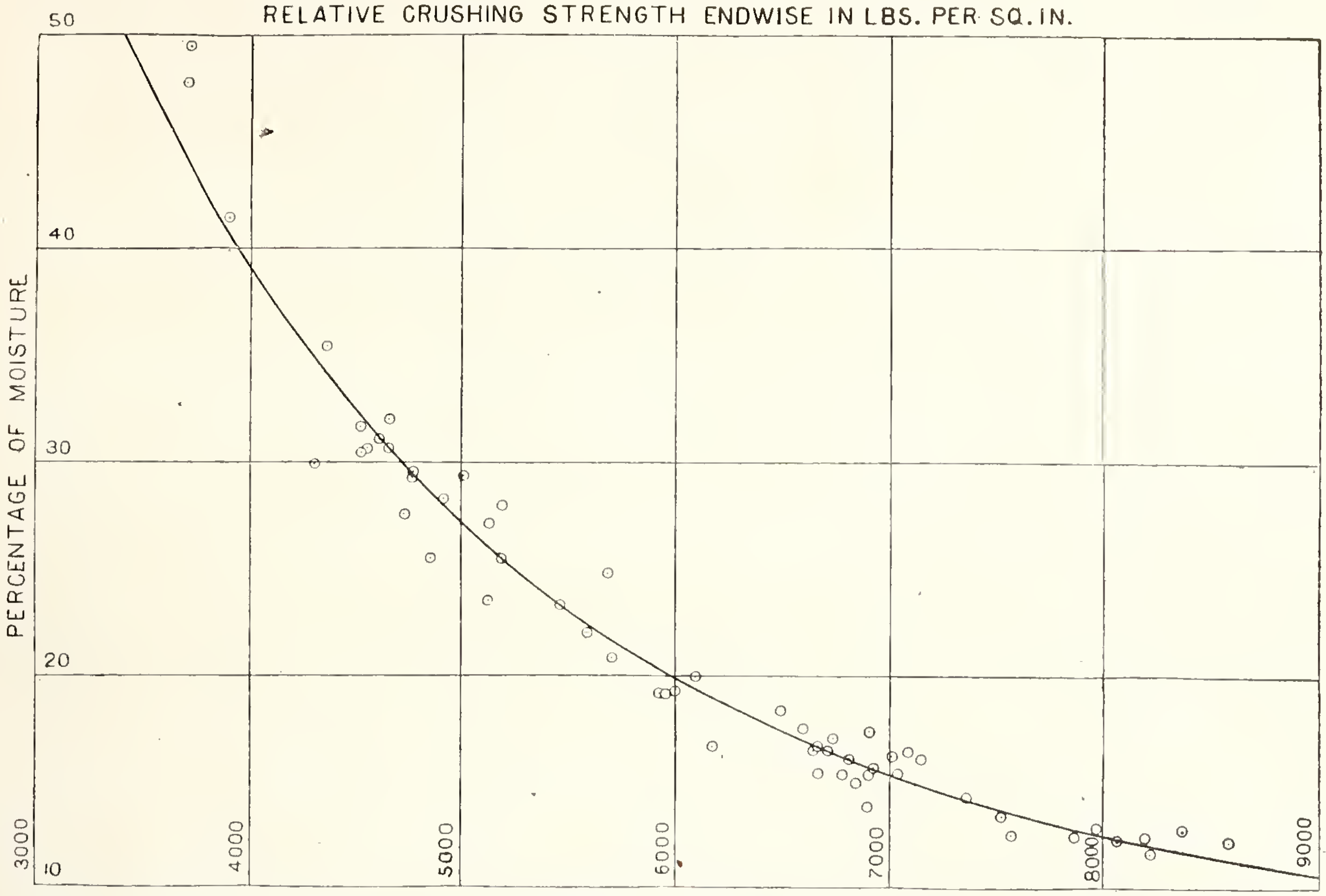


Fig. 1.—Diagram showing the increase in crushing strength endwise, with decrease in percentage of moisture.

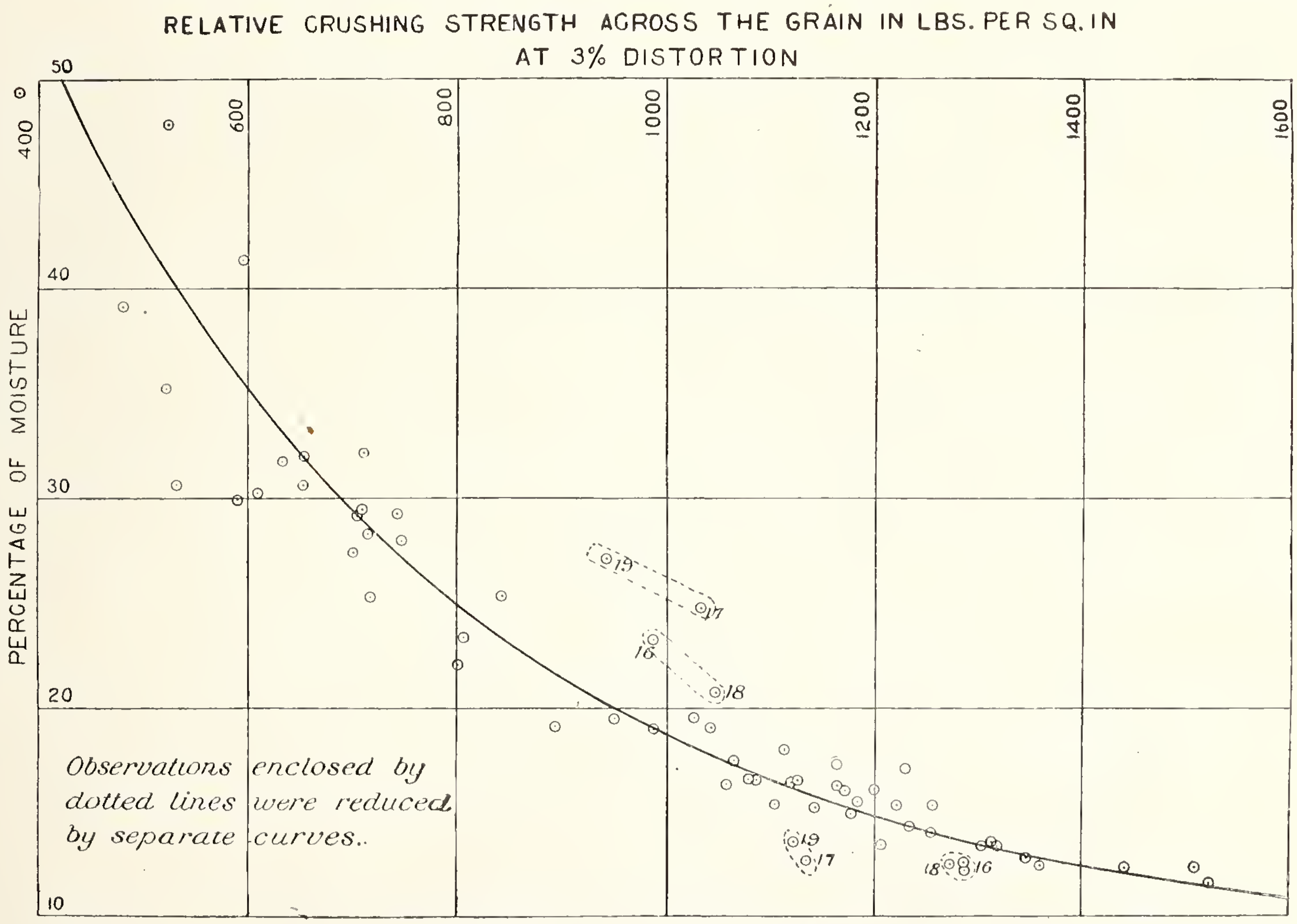


Fig. 2.—Diagram showing the increase in crushing strength across the grain, with decrease in percentage of moisture.

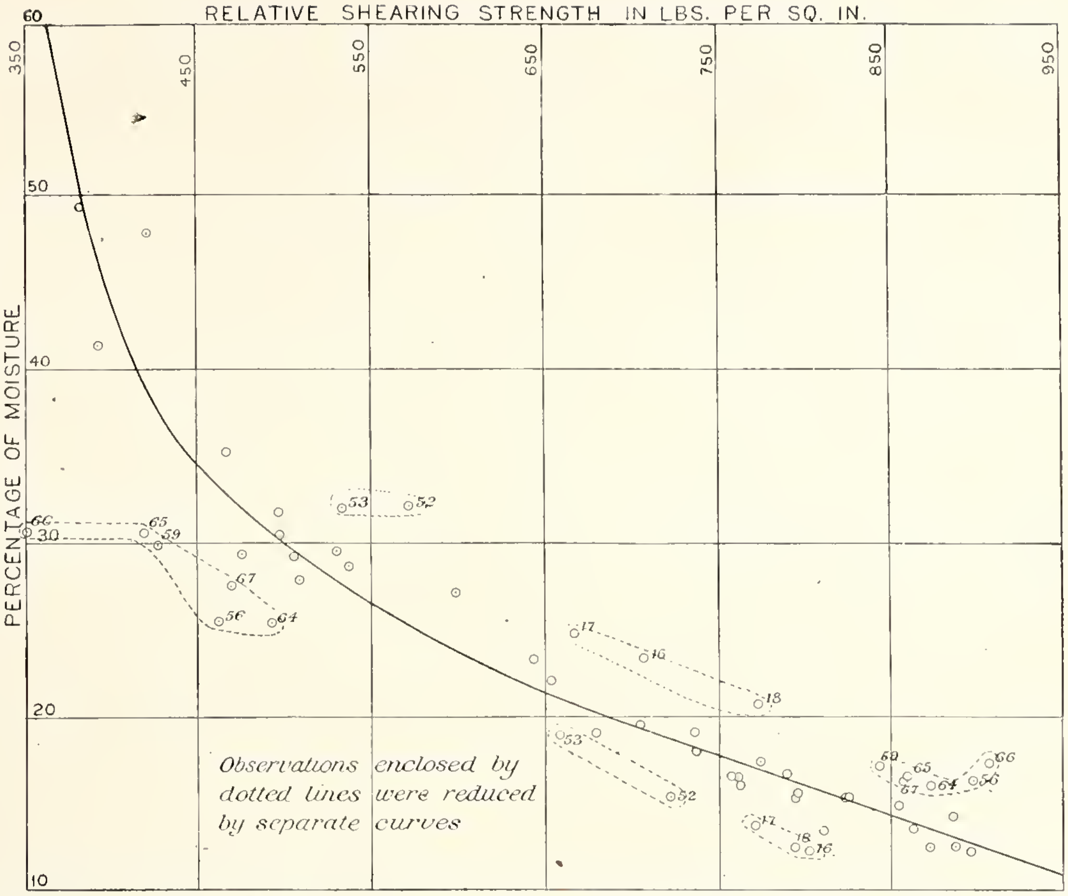


FIG. 1.—Diagram showing the increase in shearing strength, with decrease in the percentage of moisture.

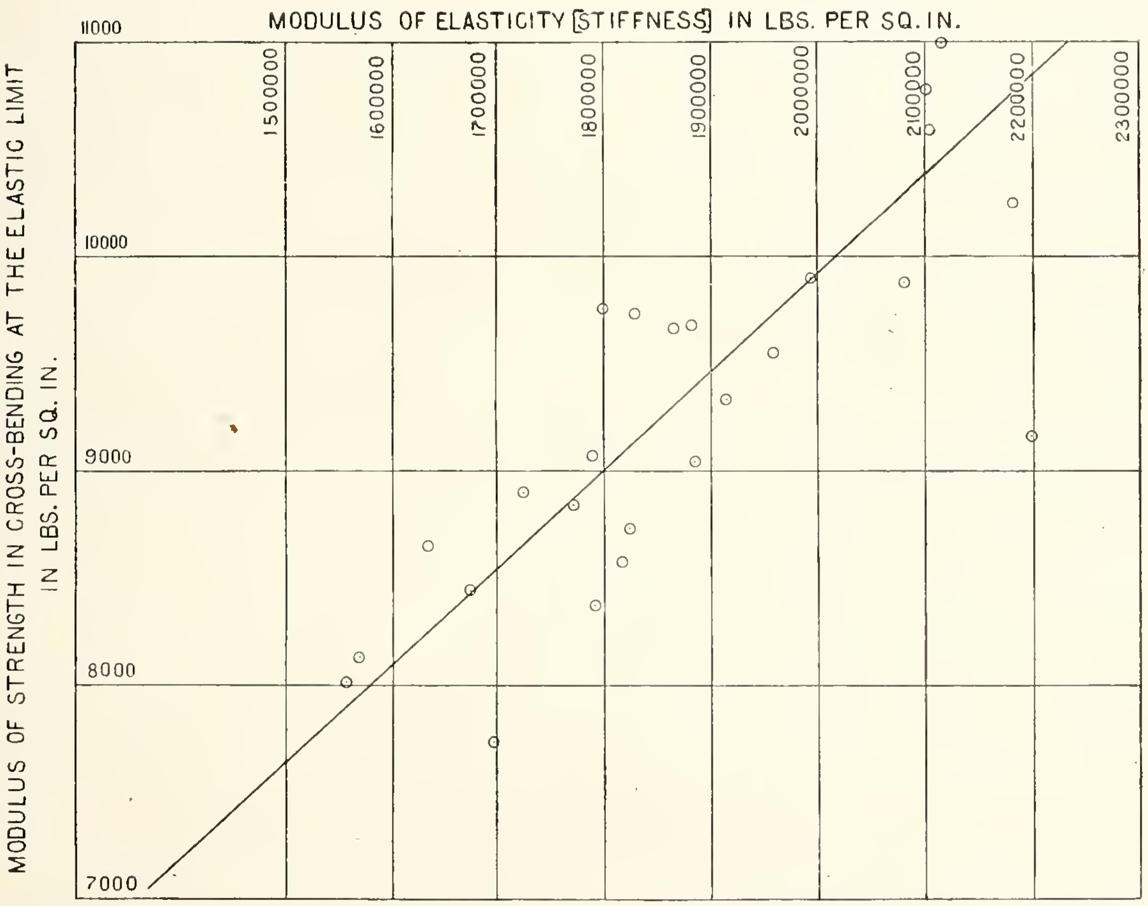


FIG. 2.—Diagram showing the relation between strength and stiffness, when reduced to 15 per cent moisture.

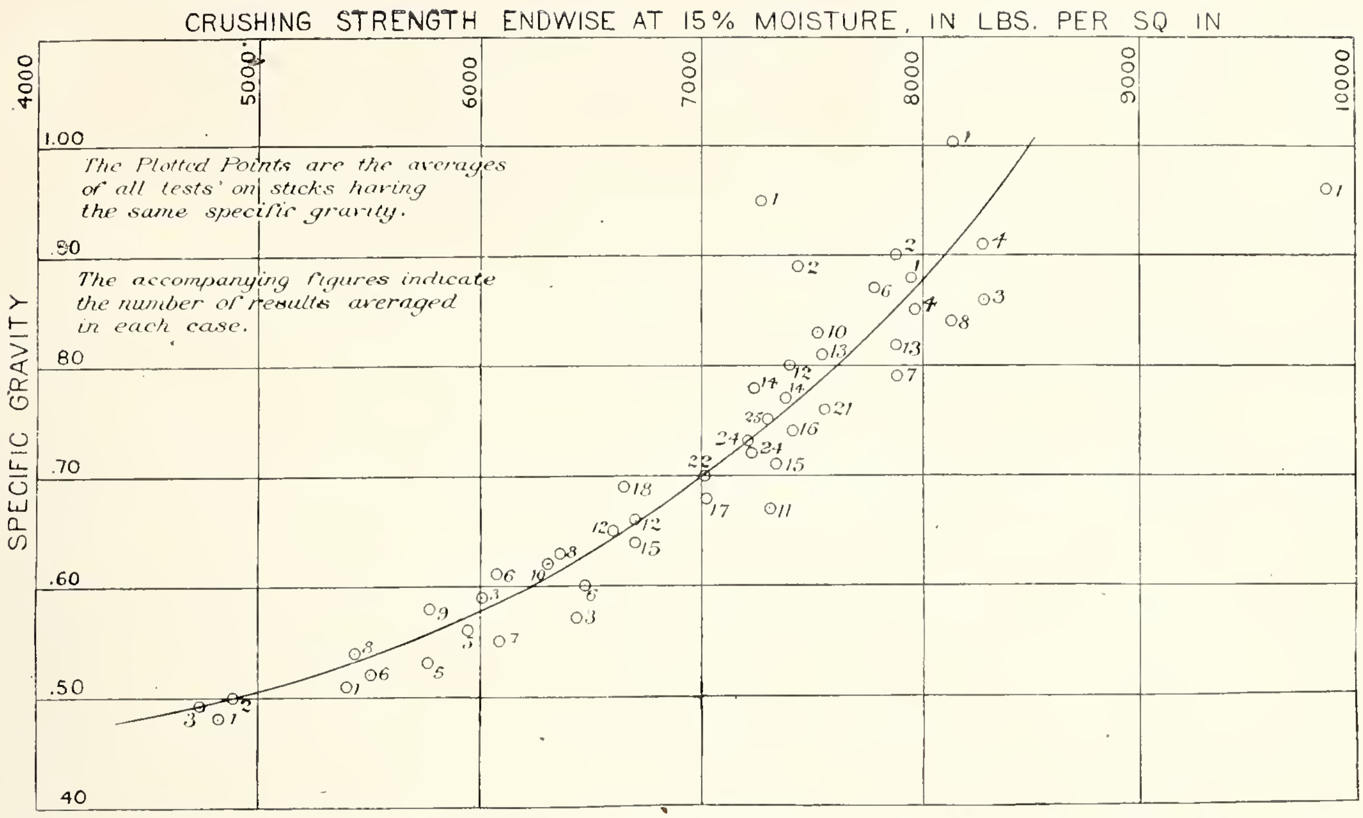


FIG. 1.—Diagram showing the crushing strength endwise and the specific gravity or weight, when reduced to 15 per cent moisture.

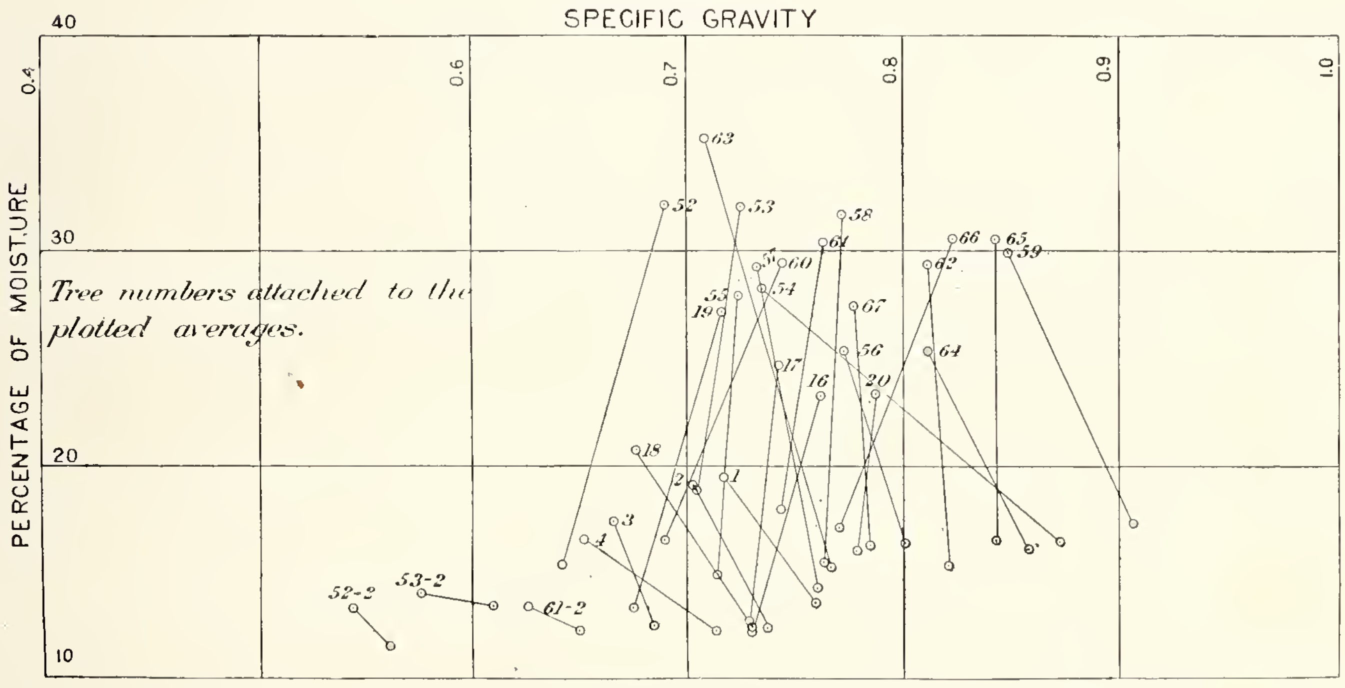


FIG. 2.—Diagram showing the absence of any material change in specific gravity, with changes in moisture, as a result of seasoning.

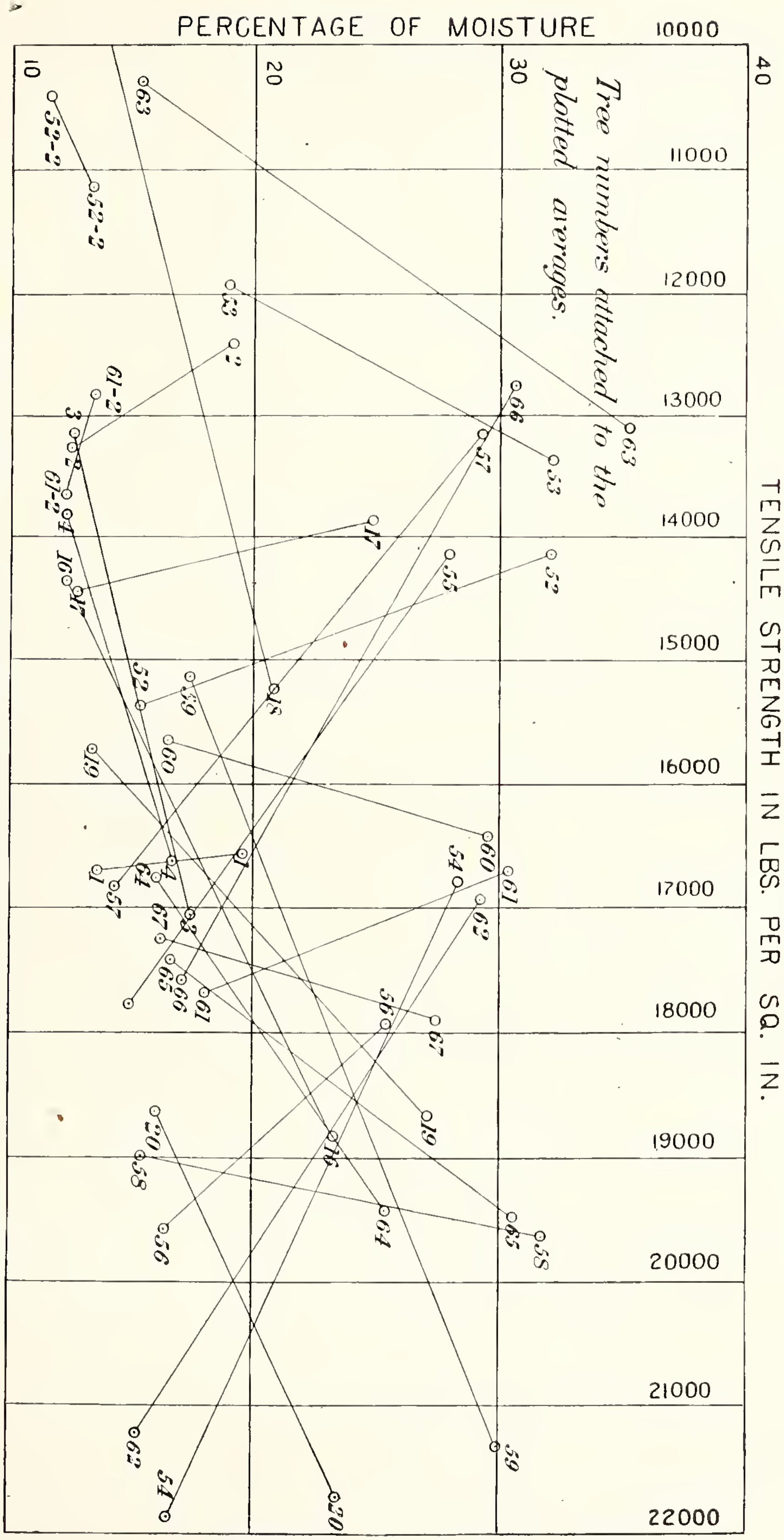


Diagram showing the absence of any general relation between tensile strength and percentage of moisture.